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## THE DEVELOPMENT OF POLITICAL INSTITUTIONS.

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### III.—POLITICAL INTEGRATION.

POLITICAL integration is in some cases furthered, and in other cases hindered, by conditions, external and internal. There are the characters of the environment, and there are the characters of the men composing the society. We will glance at them in this order.

How political integration is prevented by an inclemency of climate, or an infertility of soil, which keeps down population, has been already shown.* To the instances before named may be added that of the Seminoles, of whom Schoolcraft says, "Being so thinly scattered over a barren desert, they seldom assemble to take black drink, or deliberate on public matters"; and, again, that of certain Snake Indians, of whom he says, "The paucity of game in this region is, I have little doubt, the cause of the almost entire absence of social organization." We saw, too, that great uniformity of surface, of mineral products, of flora, of fauna, are impediments; and that on the special characters of the flora and fauna, as containing species favorable or unfavorable to human welfare, in part depends the individual prosperity required for social growth. It was also pointed out that structure of the habitat, as facilitating or impeding communication, and as rendering escape easy or hard, has much to do with the size of the social aggregate formed. To the illustrations before given, showing that mountain-haunting peoples, and peoples living in deserts and marshes, are difficult to consolidate, while peoples penned in by barriers are consolidated with facility,† I may here add two significant ones not yet noticed. One occurs in the Polynesian Islands—Tahiti, Hawaii, Ton-

* "Principles of Sociology," §§ 14–21.

† Ibid., § 17.

ga, Samoa, and the rest—where, restrained within limits by surrounding seas, the inhabitants have become united more or less closely into aggregates of considerable sizes. The other is furnished by ancient Peru, where, before the time of the Incas, semi-civilized communities had been formed in valleys separated from each other "on the coast, by hot and almost impassable deserts, and in the interior by lofty mountains, or cold and trackless *punas*." And to the implied inability of these peoples to escape governmental coercion, thus indicated by Squier as a factor in their civilization, is ascribed, by the ancient Spanish writer Cieza, the difference between them and the neighboring Indians of Popayan, who could retreat, "whenever attacked, to other fertile regions." How, conversely, within the area occupied, the massing of men together is furthered by ease of internal communication, is sufficiently manifest. The importance of it is implied by the remark of Grant concerning equatorial Africa, that "no jurisdiction extends over a district which can not be crossed in three or four days." And such facts, implying that political integration may increase as the means of going from place to place become better, remind us how, from Roman times downward, the formation of roads has made larger social aggregates possible.

Evidence that a certain type of *physique* is requisite has been elsewhere given.* We saw that the races which have proved capable of evolving large societies have been races previously subject, for long periods, to conditions fostering vigor of constitution. I will here add only that the constitutional energy needed for continuous labor, without which there can not be civilized life and the massing of men that accompanies it, is an energy not to be quickly acquired under any conditions or through any discipline, but to be acquired only by inherited modifications slowly accumulated. Good evidence that in lower types of men there is a physical incapacity for continuous labor, is supplied by the results of the Jesuit government over the Paraguay Indians. These Indians were reduced to industrial habits, and to an orderly life which was thought by many writers admirable; but there eventually resulted the fatal evil that they became infertile. Not improbably, the infertility habitually observed in savage races that have been led into civilized habits, is consequent on taxing the *physique* to a degree greater than it is constituted to bear.

Certain moral traits which favor, and others which hinder, the union of men into large groups, were pointed out when treating of "The Primitive Man—Emotional."† Here I will reillustrate such of these as concern the fitness or unfitness of the type for subordination. "The Abors, as they themselves say, are like tigers, two can not dwell in one den," writes Mr. Dalton; and "their houses are scattered singly, or in groups of two and three." Conversely, some of the African races not only yield when coerced, but admire one who coerces them;

* "Principles of Sociology," § 16. † Ibid., Part I, chapter vi.

instance the Damaras, who, as Galton says, "court slavery" and "follow a master as spaniels would." The like is alleged of other South Africans. One of them said to a gentleman known to me: "You're a pretty fellow to be a master; I've been with you two years and you've never beaten me once." Obviously the dispositions thus strongly contrasted are dispositions on which the impossibility or possibility of political integration largely depends. There must be added, as also influential, the presence or the absence of the nomadic instinct. Varieties of men, in whom wandering habits have been unchecked during countless generations of hunting life and pastoral life, show us that, even when forced into agricultural life, their tendency to move about greatly hinders aggregation. It is thus among the hill-tribes of India. "The Kookies are naturally a migratory race, never occupying the same place for more than two or, at the utmost, three years"; and the like holds of the Mishmees, who "never name their villages"—the existence of them being too transitory. In some races this migratory instinct survives and shows its effects, even after the formation of populous towns. Writing of the Bachassins in 1812, Burchell says that Litakun, containing 15,000 inhabitants, had been twice removed during a period of ten years. Clearly, people so little attached to the localities they were born in are not so easily united into large societies as people who love their early homes.

Concerning the intellectual traits which aid or impede the cohesion of men into masses, I may supplement what was said when delineating "The Primitive Man—Intellectual," * by two corollaries of much significance. Social life, being coöperative life, presupposes not only an emotional nature fitted for coöperation, but also such intelligence as perceives the benefits of coöperation, and can so regulate actions as to effect it. The unreflectiveness, the deficient consciousness of causation, and the utter lack of constructive imagination, shown by the uncivilized, hinder coöperation to a degree difficult to believe until proof is seen. Even the semi-civilized exhibit in quite simple matters an absence of concert which is astonishing.† Implying, as this inaptitude

* "Principles of Sociology," Part I, chapter vii.

† The behavior of Arab boatmen on the Nile displays this inability to coöperate in simple matters in a striking way. When jointly hauling at a rope, and beginning, as they do, to chant, the inference one draws is that they pull in time with their words. On observing, however, it turns out that their efforts are not combined at given intervals, but are put forth without any unity of rhythm. Similarly, when using their poles to push the dahabeiah off a sand-bank, the succession of grunts they severally make is so rapid that it is manifestly impossible for them to give those effectual combined pushes which imply appreciable intervals of preparation. Still more striking is the want of concert shown by the hundred or more Nubians and Arabs employed to drag the vessel up the rapids. There are shoutings, gesticulations, divided actions, utter confusion; so that only by accident does it at length happen that a sufficient number of efforts are put forth at the same moment. As was said to me by our Arab dragoman, a traveled man, "Ten Englishmen or Frenchmen would do the thing at once."

does, that coöperation can at first be effective only where there is obedience to peremptory command, it follows that there must be not only an emotional nature which produces subordination, but also an intellectual nature which produces faith in a commander. That credulity which leads to awe of the capable man, as a possessor of supernatural power, and which afterward, causing dread of his ghost, prompts fulfillment of his remembered injunctions—that credulity which initiates the religious control of a deified chief, reënforcing the control of his divine descendant—is a credulity which can not be dispensed with during early stages of integration. Skepticism is fatal while the character, moral and intellectual, is such as to necessitate compulsory coöperation.

Political integration, then, hindered in many regions by environing conditions, has, in many races of mankind, been prevented from advancing far by unfitnesses of nature—physical, moral, and intellectual.

Besides certain fitnesses of nature in the united individuals, social union requires a considerable likeness of kind in their natures. At the outset the likeness of kind is insured by greater or less kinship in blood. Evidence of this meets us everywhere among the uncivilized. Of the Bushmen, Lichtenstein says: "Families alone form associations in single small hordes; sexual feelings, the instinctive love to children, or the customary attachment among relations, are the only ties that keep them in any sort of union." Again, "The Rock Veddahs are divided into small clans or families associated for relationship, who agree in partitioning the forest among themselves for hunting-grounds," etc. And this rise of the society out of the family, seen in these least organized groups, reappears in the considerably organized groups of more advanced savages. Instance the New-Zealanders, of whom we read that "eighteen historical nations occupy the country, each being subdivided into many tribes, originally families, as the prefix Ngati, signifying offspring (equivalent to O or Mac), obviously indicates." This connection between blood-relationship and social union is well shown by Humboldt's remarks concerning South American Indians. "Savages," he says, "know only their own family, and a tribe appears to them but a more numerous assemblage of relations." When Indians who inhabit the missions see those of the forest, who are unknown to them, they say: "They are, no doubt, my relations; I understand them when they speak to me." But these very savages detest all who are not of their family or their tribe; "they know the duties of family ties and of relationship, but not those of humanity."

When treating of the domestic relations, reasons were given for concluding that social stability increases as kinships become more definite and extended; since development of kinships, while insuring the likeness of nature which furthers coöperation, involves the strengthen-

ing and multiplication of those family bonds which check disruption. Where promiscuity is prevalent, or where marriages are temporary, the known relationships are relatively few and not close; and there is little more social cohesion than results from belonging to the same type of man. Polyandry, especially of the higher kind, produces relationships of some definiteness, which admit of being traced further; so serving better to tie the social group together. And a greater advance in the nearness and the number of family connections results from polygyny. But, as was shown, it is from monogamy that there arise family connections which are at once the most definite and the most wide-spreading in their ramifications; and out of monogamic families are developed the largest and most coherent societies. In two allied yet distinguishable ways does monogamy favor social solidarity.

Unlike the children of the polyandrous family, who are something less than half brothers and sisters, and unlike the children of the polygamous family, most of whom are only half brothers and sisters, the children of the monogamous family are, in the great majority of cases, all of the same blood on both sides. Being thus themselves more closely related, it follows that their clusters of children are more closely related; and where, as happens in early stages, these clusters of children when grown up continue to form a community, and labor together, they are united alike by their kinships and by their industrial interests. Though with the growth of a family group into a *gens* which spreads, the industrial interests divide, yet these kinships prevent the divisions from becoming as marked as they would otherwise become. And, similarly, when the *gens*, in course of time, develops into the tribe. Nor is this all. If local circumstances bring together several such tribes, which are still allied in blood, though more remotely, it results that when, seated side by side, they are gradually fused, partly by interspersion and partly by intermarriage, the compound society formed, united by numerous and complicated links of kinship as well as by political interests, is more strongly bound together than it would otherwise be. Dominant ancient societies illustrate this truth. Says Grote: "All that we hear of the most ancient Athenian laws is based upon the gentile and phratric divisions, which are treated throughout as extensions of the family." Similarly, according to Mommsen, on the "Roman household was based the Roman state, both as respected its constituent elements and its form. The community of the Roman people arose out of the junction (in whatever way brought about) of such ancient clanships as the Romilii, Voltinii, Fabii, etc." And Sir Henry Maine has shown in detail the ways in which the simple family passes into the house community, and eventually the village community. Though, in presence of the evidence furnished by races having irregular sexual relations, we can not allege that sameness of blood is the primary reason for political coöperation—though in numerous tribes which have not risen into the pastoral state,

there is combination for offense and defense among those whose names are recognized marks of different bloods—yet where there has been established descent through males, and especially where monogamy prevails, sameness of blood becomes largely, if not mainly, influential in determining political coöperation. And this truth, under one of its aspects, is the truth above enunciated, that combined action, requiring a certain likeness of nature among those who carry it on, is, in early stages, most successful among those who, being descendants of the same ancestors, have the greatest likeness.

An all-important though less direct effect of blood-relationship, and especially that more definite blood-relationship which arises from monogamic marriage, has to be added. I mean community of religion—a likeness of ideas and sentiments embodied in the worship of a comman deity. Beginning, as this does, with the propitiation of the deceased founder of the family, and shared in, as it is, by the multiplying groups of descendants, as the family spreads, it becomes a further means of holding together the compound cluster gradually formed, and checking the antagonisms that arise between the component clusters: so favoring integration. The influence of the bond supplied by a common cult everywhere meets us in ancient history. Each of the cities in primitive Egypt was a center for the worship of a special divinity; and no one who, unbiased by foregone conclusions, observes the extraordinary development of ancestor-worship, under all its forms, in Egypt, can doubt the origin of this divinity. Of the Greeks we read that "each family had its own sacred rites and funereal commemoration of ancestors, celebrated by the master of the house, to which none but members of the family were admissible: the extinction of a family, carrying with it the suspension of these religious rites, was held by the Greeks to be a misfortune, not merely from the loss of the citizens composing it, but also because the family gods and the manes of deceased citizens were thus deprived of their honors and might visit the country with displeasure. The larger associations, called Gens, Phratry, Tribe, were formed by an extension of the same principle—of the family considered as a religious brotherhood, worshiping some common god or hero with an appropriate surname, and recognizing him as their joint ancestor."

A like bond was generated in a like manner in the Roman community. Each curia, which was the homologue of the phratry, had a head, "whose chief function was to preside over the sacrifices." And, on a larger scale, the same thing held with the entire society. The primitive Roman king was a priest of the deities common to all; "he held intercourse with the gods of the community, whom he consulted and whom he appeased." The beginnings of this religious bond, here exhibited in a developed form, are still traceable in India. Sir Henry Maine says, "The joint family of the Hindoos is that assemblage of persons who would have joined in the sacrifices at the funeral of

some common ancestor if he had died in their lifetime." So that political integration, while furthered by that likeness of nature which identity of descent involves, is again furthered by that likeness of religion simultaneously arising from this identity of descent.

Thus is it, too, at a later stage, with that less pronounced likeness of nature characterizing men of the same race who have multiplied and spread in such ways as to form adjacent small societies. Coöperation among them continues to be furthered, though less effectually, by the community of their natures, by the community of their traditions, ideas, and sentiments, as well as by their community of language. Among men of diverse types, coöperation is necessarily hindered not only by that absence of mutual comprehension caused by ignorance of one another's words, but also by unlikenesses in their ways of thinking and feeling. It needs but to remember how often, even among those who speak the same language, quarrels arise from misinterpretations of things said, to see what fertile sources of confusion and antagonism must be the partial or complete differences of speech which habitually accompany differences of race. Similarly, those who are widely unlike in their emotional natures, or in their intellectual natures, perplex one another by unexpected conduct—a fact on which travelers habitually remark. Hence a further obstacle to combined action. Diversities of custom, too, become causes of dissension. Where a food eaten by one people is regarded by another with disgust, where an animal held sacred by the one is by the other treated with contempt, where a salute which the one expects is never made by the other, there must be continually generated alienations which hinder joint efforts. Other things equal, facility of coöperation will be proportionate to the amount of fellow-feeling; the fellow-feeling is prevented by whatever prevents men from behaving in the same ways under the same conditions. The working together of the original and derived factors above enumerated is well exhibited in the following passage from Grote: "The Hellens were all of common blood and parentage—were all descendants of the common patriarch Hellen. In treating of the historical Greeks, we have to accept this as a datum: it represents the sentiment under the influence of which they moved and acted. It is placed by Herodotus in the front rank, as the chief of those four ties which bound together the Hellenic aggregate: 1. Fellowship of blood; 2. Fellowship of language; 3. Fixed domiciles of gods, and sacrifices common to all; 4. Like manners and dispositions."

Influential as we thus find to be the likeness of nature which is insured by common descent, the implication is that, in the absence of considerable likeness, the larger political aggregates formed are unstable, and can be maintained only by a coercion which, some time or other, is sure to fail. Though other causes have conspired, yet this has doubtless been a part cause of the dissolution of great empires in past ages. At the present time the decay of the Turkish Empire is

largely if not chiefly ascribable to it. Our own Indian Empire, too, held together by force in a state of artificial equilibrium, threatens some day to illustrate, by its fall, the incohesion arising from lack of congruity in its components.

One of the laws of evolution at large is, that integration results when like units are subject to the same force or to like forces ("First Principles," § 169); and, from the first stages of political integration up to the last, we find this law illustrated. Joint exposure to uniform external actions and joint reactions against them have from the beginning been the leading causes of union among members of societies.

Already there has been indirectly implied the truth that coherence is first given to small hordes of primitive men during combined opposition to enemies. Subject to the same danger, and uniting to meet this danger, they become, in the course of their coöperation against it, more bound together. In the first stages, this relation of cause and effect is clearly seen in the fact that such union as arises during a war disappears when the war is over: there is dispersion and loss of all such slight political subordination as was beginning to show itself. But it is by the integration of simple groups into compound groups, in the course of common resistance to foes and attacks upon them, that this process is best exemplified. The cases before given may be reënforced by others. Of the Karens, Mason says: "Each village, being an independent community, had always an old feud to settle with nearly every other village among their own people. But the common danger from more powerful enemies, or having common injuries to requite, often led to several villages uniting together for defense or attack." According to Kolben, "smaller nations of Hottentots, which may be near some powerful nation, frequently enter into an alliance, offensive and defensive, against the stronger nation." Among the New Caledonians, in Tanna, "six, or eight, or more of their villages unite, and form what may be called a district, or county, and all league together for mutual protection. . . . In war, two or more of these districts unite." In Samoa, "villages, in numbers of eight or ten, unite by common consent, and form a district or state for mutual protection"; and, in time of war, these districts themselves sometimes unite in twos and threes. The like has happened with historic peoples. It was during the wars of the Israelites, in David's time, that they passed from the state of separate tribes into the state of a consolidated ruling nation. The scattered Greek communities, previously aggregated into minor confederacies by minor wars, were prompted to the Panhellenic congress and to the subsequent coöperation, when the invasion of Xerxes was impending; and, of the Spartan and Athenian confederacies afterward formed, that of Athens acquired the hegemony, and finally the empire, during continued operations

against the Persians. So, too, was it with the Teutonic races. The German tribes, originally without federal bond, formed occasional alliances for war. Between the first and fifth centuries these tribes gradually massed into great groups for resistance against or attack upon Rome. During the subsequent century the prolonged military confederations of peoples "of the same blood" had become states. And afterward these became aggregated into still larger states. And, to take a comparatively modern instance, it was during the wars between France and England that each passed from that condition, in which its component feudal groups were in considerable degrees independent, to the condition of a consolidated nation. As further showing how integration of smaller societies into larger ones is thus initiated, it may be added that at first the unions exist only for military purposes: each component society retains for a long time its independent internal administration, and it is only when joint action in war has become habitual that the cohesion is made permanent by a common political organization.

This compounding of smaller communities into larger by military coöperation is insured by the disappearance of such smaller communities as do not coöperate. Barth remarks that "the Fúlbe [Fulahs] are continually advancing, as they have not to do with one strong enemy, but with a number of small tribes without any bond of union." Of the Damaras, Galton says: "If one werft is plundered, the adjacent ones rarely rise to defend it, and thus the Namaquas have destroyed or enslaved piecemeal about one half of the whole Damara population." Similarly, according to Ondegardo, with the Inca conquests in Peru: "There was no general opposition to their advance, for each province merely defended its land without aid from any other." This process, so obvious and familiar, I name because it has a meaning which needs emphasizing. For we here see that, in the struggle for existence among societies, the survival of the fittest is the survival of those in which the power of military coöperation is the greatest; and military coöperation is that primary kind of coöperation which prepares the way for other kinds of coöperation. So that this formation of larger societies by the union of smaller ones in war, and this destruction or absorption of the smaller ununited societies by the united larger ones, is an inevitable process through which the varieties of men most adapted for social life supplant the less adapted varieties.

Respecting the integration thus effected, it remains only to remark that it necessarily follows this course—necessarily begins with the formation of simple groups and advances by the compounding and the recompounding of these. Impulsive in conduct and with feeble powers of coöperation, savages cohere so slightly that only small bodies of them can maintain their integrity. Not until such small bodies have severally had their members bound to one another by some slight political organization does it become possible to unite them into larger

bodies; since the cohesion of these implies greater fitness for concerted action, and more developed organization for achieving it. And, similarly, these composite clusters must be to some extent consolidated before the composition can be carried a stage further. Passing over the multitudinous illustrations occurring among the uncivilized, it will suffice if I refer to those given before,* and reënforce them by some which historic peoples have supplied. There is the fact that in primitive Egypt the numerous small societies (which eventually became the "nomes") first united into the two aggregates, Upper Egypt and Lower Egypt, which were afterward joined into one; and the fact that, in ancient Greece, villages became united to adjacent towns before the towns became united into states, while this change preceded the change which united the states with one another; and the fact that, in the old English period, small principalities were massed into the divisions constituting the Heptarchy before these passed into something like a united whole. It is a principle in physics that, since the force with which a body resists strains increases only as the squares of its dimensions, while the strains which its own weight subject it to increase as the cubes of its dimensions, its power of maintaining its integrity becomes relatively less as its mass becomes greater. Something analogous may be said of societies. Small aggregates only can hold together while the cohesion is feeble, and successively larger aggregates become possible only as the greater strains implied are met by that greater cohesion which results from an adapted human nature, and a resulting development of social organization.

As social integration advances, the increasing aggregates exercise increasing restraints over their units—a truth which is the obverse of the one just set forth, that the maintenance of its integrity by a larger aggregate implies greater cohesion. The coercive forces by which aggregates keep their units together are at first very slight, and, becoming extreme at a certain stage of social evolution, afterward relax —or, rather, change their forms.

At the outset the individual savage gravitates to one group or other, prompted by sundry motives, but mainly by the desire for protection. Concerning the Patagonians, we read that no one can live apart: "If any of them attempted to do it, they would undoubtedly be killed, or carried away as slaves, as soon as they were discovered." In North America, among the Chinooks, "on the coast a custom prevails which authorizes the seizure and enslavement, unless ransomed by his friends, of every Indian met with at a distance from his tribe, although they may not be at war with each other." At first, however, though it is necessary to join some group, it is not necessary to continue in the same group. In early stages migrations from group to group are common. When much oppressed by their chief, Calmucks

* "Principles of Sociology," § 226.

and Mongols desert him and go over to other chiefs. Of the Abipones, Dobrizhoffer says: "Without leave asked on their part, or displeasure evinced on his, they remove with their families whithersoever it suits them, and join some other cacique; and, when tired of the second, return with impunity to the horde of the first." Similarly, in South Africa, "the frequent instances which occur [among the Balonda] of people changing from one part of the country to another show that the great chiefs possess only a limited power." And how, through this process, some tribes grow while others dwindle, we are shown by McCulloch's remark respecting the Kukis, that "a village, having around it plenty of land suited for cultivation and a popular chief, is sure soon, by accessions from less favored ones, to become large."

With the need which the individual has for protection is joined the desire of the tribe to strengthen itself; and the practice of adoption, hence resulting, constitutes another mode of integration. Where, as among tribes of North American Indians, "adoption or the torture were the alternative chances of a captive" (adoption being the fate of one admired for his bravery), we see reillustrated the tendency which each society has to grow at the expense of other societies. That desire for many actual children whereby the family may be strengthened, which Hebrew traditions show us, readily passes into the desire for factitious children—here made one with the brotherhood by exchange of blood, and there by mock birth. As was implied in another place,* it is probable that the practice of adoption into families so prevalent in Rome arose during those early times when the wandering patriarchal group constituted the tribe, and when the desire of the tribe to strengthen itself was dominant. And, indeed, on remembering that, long after larger societies were formed by the compounding of patriarchal groups, there continued to be feuds between the component families and clans, we may see that there had never ceased to operate, on such families and clans, the primitive motive for strengthening themselves by increasing their numbers.

It may be added that kindred motives produced kindred results within more modern societies, during times when their component parts were so imperfectly integrated that there remained antagonisms among them. Thus we have the fact that in mediæval England, while local rule was incompletely subordinated to general rule, every free man had to attach himself to a lord, a burgh, or a guild: being otherwise "a friendless man," and in a danger like that which the savage is in when not belonging to a tribe. And then, on the other hand, in the law that, "if a bondsman continued a year and a day within a free burgh or municipality, no lord could reclaim him," we may recognize an effect of the desire on the part of industrial groups to strengthen themselves against the feudal groups around—an effect analogous to the adoption, here into the savage tribe and there into the family

* "Principles of Sociology," § 319.

as it existed in the ancient societies. Naturally, as a whole nation becomes more completely integrated, these local integrations become weaker, and finally disappear; though they long leave their traces, as among ourselves even still in the law of settlement, and as, up to so late a period as 1824, in the laws affecting the freedom of traveling of artisans.

These last illustrations introduce us to the truth that, while at first there are little cohesion and great mobility of the units forming a group, advance in integration is habitually accompanied not only by a decreasing ability to go from group to group, but also by a decreasing ability to go from place to place with the group: the members of the society become less free to move about within the society as well as less free to leave it. Of course, the transition from the nomadic to the settled state partially implies this; since each person becomes in a considerable degree tied by his material interests. Slavery, too, effects in another way this binding of individuals to locally-placed members of the society, and therefore to particular parts to it; and, where serfdom exists, the same thing is shown with a difference. But in societies that have become highly integrated, not simply those in bondage, but others also, are tied to their localities. Of the ancient Mexicans, Zurita says: "The Indians never changed their village nor even their quarter. This custom was observed as a law." In ancient Peru, "it was not lawful for any one to remove from one province, or village, to another"; and "any who traveled without just cause were punished as vagabonds." Elsewhere, along with that development of the militant type accompanying aggregation, there have been imposed restraints on movement under other forms. In ancient Egypt there existed a system of registration, and all citizens had periodically to report themseves to local officers. "Every Japanese is registered, and, whenever he removes his residence, the Nanushi, or head-man of the temple, gives a certificate." And then, in despotically governed European countries, we have more or less rigorous passport-systems, hindering the movements of citizens from place to place, and in some cases preventing them from leaving the country.

In these, as in other respects, however, the restraints which the social aggregate exercises over its units decrease as the industrial type begins greatly to qualify the militant type; partly because the societies characterized by industrialism are amply populous, and have superfluous members to fill the places of those who leave them, and partly because, in the absence of the oppressions accompanying a militant *régime*, a sufficient cohesion results from pecuniary interests, family bonds, and love of country.

Thus, saying nothing for the present of that political evolution manifested by increase of structure, and restricting ourselves to that political evolution manifested by increase of mass, here dis-

tinguished as political integration, we find that this has the following traits :

While the aggregates are small, the incorporation of materials for growth is carried on at one another's expense in feeble ways—by taking one another's game, by robbing one another of women, and, occasionally, by adopting one another's men. As larger aggregates are formed, incorporations proceed in more wholesale ways : first, by enslaving the separate members of conquered tribes, and presently by the bodily annexation of such tribes. And, as compound aggregates pass into doubly and trebly compound ones, there arise increasing desires to absorb adjacent smaller societies, and so to form still larger aggregates.

Conditions of several kinds further or hinder social growth and consolidation. The habitat may be fitted or unfitted for supporting a large population ; or it may, by great or small facilities for intercourse within its area, favor or impede coöperation ; or it may, by presence or absence of natural barriers, make easy or difficult the keeping together of the individuals under that coercion which is at first needful. And, as the antecedents of the race determine, the individuals may have in greater or less degrees the physical, the emotional, and the intellectual natures fitting them for combined action.

While the extent to which social integration can in each case be carried depends in part on these conditions, it also depends in part upon the degree of likeness among the units. At first, while the nature is so little molded to social life that cohesion is small, aggregation is largely dependent on ties of blood, implying great degrees of likeness. Groups in which such ties, and the resulting congruity, are most marked, and which, having family traditions in common, a common male ancestor, and a joint worship of him, are in these further ways made alike in ideas and sentiments, are groups in which the greatest social cohesion and power of coöperation arise. For a long time the clans and tribes descending from such primitive patriarchal groups have their political concert facilitated by this bond of relationship and the likeness it involves. Only after adaptation to social life has made considerable progress does harmonious coöperation among those who are not of the same stock become practicable ; and even then their unlikenesses of nature must fall within moderate limits. Where the unlikenesses of nature are great, the society, held together only by force, tends to disintegrate when the force fails.

Likeness in the units forming a social group being one condition of their integration, a further condition is their joint reaction against external action ; coöperation in war is the active cause of social integration. The temporary unions of savages for offense and defense show us the initiatory step. When many tribes unite against a common enemy, long continuance of their combined action makes them

coherent under some common control. And so it is subsequently with still larger aggregates.

Progress in social integration is both a cause and a consequence of a decreasing separableness among the units. Primitive wandering hordes exercise no such restraints over their members as prevent them individually from leaving one horde and joining another at will. Where tribes are more developed, desertion of one and admission into another are less easy—the assemblages are not so loose in composition. And, throughout those long stages during which societies are being enlarged and consolidated by militancy, the mobility of the units is more and more restrained. Only with that substitution of voluntary coöperation for compulsory coöperation which characterizes developing industrialism do these restraints disappear: enforced union being in such societies adequately replaced by spontaneous union.

A remaining truth to be named is that political integration, as it advances, tends to obliterate the original divisions among the united parts. In the first place, there is the slow disappearance of those non-topographical divisions arising from relationship, and resulting in separate gentes and tribes, gentile and tribal divisions, which are for a long time maintained after larger societies have been formed: gradual intermingling destroys them. In the second place, the smaller local societies united into a larger one, which at first retain their separate organizations, lose them by long coöperation: a common organization begins to ramify through them, and their individualities become indistinct. And, in the third place, there simultaneously results a more or less decided obliteration of their topographical bounds, and a replacing of these by the new administrative bound of the common organization. Hence naturally results the converse truth that, in the course of social dissolution, the great groups separate first, and afterward, if dissolution continues, these separate into their component smaller groups. Instance the ancient empires successively formed in the East, the united kingdoms of which severally resumed their autonomies when the coercion keeping them together ceased. Instance, again, the Carlovingian empire, which, first parting into its large divisions, became in course of time further disintegrated by subdivision of these. And where, as in this last case, the process of dissolution goes very far, there is a return to something like the primitive condition, under which small predatory societies are engaged in continuous warfare with like small societies around them.

# PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

## DIET.

"Blessed are the pure, for they can follow their inclinations with impunity."

UNNATURAL food is the principal cause of human degeneration. It is the oldest vice. If we reflect upon the number of ruinous dietetic abuses, and their immemorial tyranny over the larger part of the human race, we are tempted to eschew all symbolical interpretations of the paradise legend, and to ascribe the fall of mankind literally and exclusively to the eating of forbidden food. From century to century the same cause has multiplied the sum of our earthly ills. Substances which Nature never intended for the food of man have come to form a principal part of our diet; caustic spices torture our digestive organs; we ransack every clime for noxious weeds and intoxicating fluids; from twenty to thirty-five per cent. of our breadstuffs are yearly wasted on the distillation of a life-consuming fire; vegetable poisons, inorganic poisons, and all kinds of indigestible compounds enslave our appetites, and among the Caucasian nations of the present age an unexampled concurrence of causes has made a passive submission to that slavery the habitual condition.

Dietetic abuses, alone, would amply account for all our "ailments and pains, in form, variety, and degree beyond description"; the vitality of the human race would, indeed, have long succumbed to their combined influence, if their effects were not counteracted by the reconstructive tendency of Nature. Every birth is an hygienic regeneration. The constitutional defects which degenerate parents transmit to their offspring are modified by the inalienable bequest of an elder world—the redeeming instincts which our All-mother grants to every new child of earth. Individuals may deprave these instincts till their functions are entirely usurped by the cravings of a vicious appetency, but this perversion is never hereditary; Nature has ordained that all her children should begin the pilgrimage of life from beyond the point where the roads of misery and happiness diverge. As the golden age, the happy childhood of the human race returns in the morning of every life, the normal type of our primogenitor asserts itself athwart the morbid influences of all intermediate generations; the regenesis of every new birth brings mankind back from vice to innocence, from mysticism to realism, from ghost-land to earth. For a time those better instincts thwart the influence of miseducation as persistently as confirmed vices afterward thwart the success of reformatory measures; but, if the work of correct physical culture were begun in time, our innate propensities

themselves would conspire to further its purposes and bar the boundary between virtue and vice which conscience often guards in vain. The temptations that beset the path of the adult convert do not exist for the wards of Nature. To the palate of a normal child, alcohol is as unattractive as corrosive sublimate; the enforced inactivity of our limbs, which afterward becomes dyspeptic indolence, is as irksome to a healthy boy as to a wild animal, and a young Indian would prefer the open air of the stormiest winter night to the hot miasma of our tenement-houses. Few smokers can forget the effects of the diffident first attempt—the revolt of the system against the incipience of a virulent habit. The same with other abuses of our domestic and social life. If we would preserve the purity of our physical conscience, we might refer all hygienic problems to an unerring oracle of Nature.

The appearance of the eye-teeth (cuspids) and lesser molars marks the end of the second year as the period when healthy children may be gradually accustomed to semi-fluid vegetable substances. Till then, milk should form their only sustenance. As a substitute for the nourishment of their mother's breast, cow's-milk, mixed with a little water and sugar, is far superior to all patent paps, Liebig's compounds, and baby-soups, which often induce a malignant attack of the dysenteric complaint known as "bowel-fever" or "weaning-brash," unless palliated by still more condemnable astringents and soothing-sirups. In France the professional wet-nurses of the Pays de Vaud are generally engaged as *nourrices de deux ans;* but mothers whose employment does not interfere with their inclination in this respect may safely nurse their children for a much longer period. The wives of the sturdy Argyll peasants rarely wean a bairn before its claim is disputed by the next youngster; and the stoutest urchin of five years I ever saw was the son of a poor Servian widow, who still took him to her breast like a baby. Animals suckle their young till they are able to digest the unmodified solid food of the species; and the best method with weanlings, therefore, is perhaps that of the Ionian-Islanders, whose toddling infants, as Dr. Bodenstedt noticed, partake of the simple repast of their parents—unleavened maize-cakes and dried figs—and are often permitted to exercise their teeth on a fresh-plucked ear of sugar-corn. But, in countries where the repast of parents is anything but simple, the best food for young children is a porridge of milk and boiled rice or oatmeal, with a little sugar, perhaps, or a few spoonfuls of apple-butter in summer-time. Of such simple dishes a child may be permitted to eat its fill, but they should be served at regular intervals and never be taken hot. Heating our food is one of the many devices for disguising its natural taste, and sipping hot and cold drinks, turn about, is far more injurious to the teeth than the *penchant* for sweetmeats which children share with savages and monkeys. Beginning with five light meals a day, the number may be gradually reduced to three, after which a system of fixed hours should be strictly observed, till the symptoms of

appetite manifest a corresponding periodicity, thus saving mothers the trouble of providing baby-titbits at all possible and impossible hours of the day. Healthy children of five take readily to an exclusively vegetable diet, which is often preferable to city milk and always to flesh-food. Xenophon, in his miscellaneous "Anabasis," mentions a tribe of Bithynian coast-dwellers whose children were prodigies of chubbedness, "as thick as they were long," and remarks that said chubs were fed on—boiled chestnuts. Baked apples, pulse, macaroni, whipped eggs, bread-pudding seasoned with sugar and a drop or two of lemon-flavor, and such fruits as mellow pears, raspberries, and strawberries, can be readily assimilated by all but the weakliest nursery cadets.

But toward the end of the seventh year the advent of a second and sturdier set of teeth suggests the propriety of exercising the jaws on more solid substances. A child of seven should graduate to a seat at the family table; or rather the family table should offer nothing that a child of seven can not digest. It does, though, as a rule, and parents who buy their meals ready made, or who have resigned themselves to evils from which they would save their children, should still regulate their bill of fare, both in quality and in quantity, by the rules of hygiene rather than by those of etiquette or convenience, till the age of confirmed habits puts them beyond the danger of temptation.

Before entering upon those points, I must premise a few words on the main question, What is the natural food of man? As an abstract truth, the maxim * of the physiologist Haller is absolutely unimpeachable: "Our proper nutriment should consist of vegetable and semi-animal substances which can be eaten with relish before their natural taste has been disguised by artificial preparation." For even the most approved modes of grinding, bolting, leavening, cooking, spicing, heating, and freezing our food are, strictly speaking, abuses of our digestive organs. It is a fallacy to suppose that hot spices aid the process of digestion: they irritate the stomach and cause it to discharge the ingesta as rapidly as possible, as it would hasten to rid itself of tartarized antimony or any other poison; but this very precipitation of the gastric functions prevents the formation of healthy chyle. There is an important difference between rapid and thorough digestion. In a similar way, a high temperature of our food facilitates deglutition, but, by dispensing with insalivation and the proper use of our teeth, we make the stomach perform the work of our jaws and salivary glands; in other words, we make our food less digestible. By bolting our flour and extracting the nutritive principle of various liquids, we fall into the opposite error: we try to assist our digestive organs by performing mechanically a part of their proper and legitimate functions. The health of the human system can not be maintained on concentrated nutriment; even the air we inhale contains azotic

* Endorsed (indirectly) in the writings of Drs. Alcott, Claude Bernard, Schlemmer, Hall, and Dio Lewis, and directly by Schrodt and Jules Virey.

gases which must be separated from the life-sustaining principle by the action of our respiratory organs—not by any inorganic process. We can not breathe pure oxygen. For analogous reasons bran-flour makes better bread than bolted flour; meat and saccharine fruits are healthier than meat-extracts and pure glucose. In short, artificial extracts and compounds are, on the whole, less wholesome than the palatable products of Nature. In the case of bran-flour and certain fruits with a large percentage of wholly innutritious matter, chemistry fails to account for this fact, but biology suggests the mediate cause: the normal type of our physical constitution dates from a period when the digestive organs of our (frugivorous) ancestors adapted themselves to such food—a period compared with whose duration the age of grist-mills and made dishes is but of yesterday.

We can not doubt that the highest degree of health could only be attained by strict conformity to Haller's rule, i. e., by subsisting exclusively on the pure and unchanged products of Nature. In the tropics such a mode of life would not imply anything like asceticism: a meal of milk and three or four kinds of sweet nuts, fresh dates, bananas, and grapes would not clash with the still higher rule, that eating, like every other natural function, should be a pleasure and not a penance. Heat destroys the delicate flavor of many fruits and makes others less digestible by coagulating their albumen. But in the frigid latitudes, where we have to dry and garner many vegetable products in order to survive the unproductive season, the process of cooking our food has advantages which fully outweigh such objections. Few men with post-diluvian teeth would agree with Dr. Schlemmer that hard grain is preferable to bread. No Bostoner would renounce his favorite dish for a nose-bag full of dry beans. Dried prunes, too, are improved by cooking—in taste, at least, and perhaps in digestibility. Besides, we should not forget that the natural taste of such substances, before they became over-dry, *was* agreeable, or at least not repulsive to our palates. It appears that on week-days the children of Israel indulged their poor in the practice of snatching free luncheons from a convenient corn-field (Matthew xii, 1), and the Imam of Muscat still feeds his soldiers on crude wheat and dhourra-corn, a sort of millet, which many French soldiers learned to eat raw, as their Mameluke captors declined to cook it for them. Even the legumes—peas, beans, and lentils—pass through a period when they are soft and full of sweet milk-juice, though in their sun-dried over-ripeness they become as tough as wood. In the scale of wholesomeness the place next to Haller's man-food *par excellence* should therefore be assigned to vegetable substances whose pleasant taste has been *restored* by the process of cooking. With this addition, even an invalid, dieting for his health, need not complain of lack of variety, for the number of nutritious vegetables that can be successfully cultivated as far north as Hamburg and Boston is almost infinite if we include the plants of the corresponding Asiatic latitudes

and those that could be acclimatized in the course of five or six seasons. With five kinds of cereals, three legumina, eight species of esculent roots, ten or twelve nutritive herbs, thirty to forty varieties of tree-fruits, besides berries and nuts, a vegetarian might emulate the Duc de Polignac, who refused to eat the same dish more than once per season. Honey is the pure, unchanged, and unalloyed saccharine juice of flowers and resinous exudations, and therefore strictly a vegetable substance, though Carl Bock and Bichat describe it as semi-animal food, because "derived from animals," i. e., hived by bees. They might as well include flour under the same category because horses carry grist to the mill. Like sugar, vanilla, and the manna-sirup of Arabia Felix, we might class it with the non-stimulating condiments, which, used in moderate quantities, impart an agreeable flavor to many farinaceous preparations without impairing their digestibility.

Of all semi-animal substances, sweet fresh milk is the most wholesome, in itself an almost perfect aliment, welcome to all mammals and nearly all vertebrate animals. Monkeys, cats, deer, squirrels, otters, and ant-bears, creatures that differ so widely in their *special* diet, will rarely refuse a dish of this universal food. I have seen snakes and iguanas drink it with avidity. On the other hand, I have noticed that all animals but pigs and starved dogs eschew sour milk; it is, properly speaking, fermented milk, to the taste of a normal man probably as repulsive as tainted meat or sour gruel. This fermentation affects the fatty particles less than the watery and caseine; and butter and cream (though less digestible than fresh milk) are, therefore, far healthier than sour whey and cheese. Cheese in some of its forms is quite as unwholesome as rotten flesh; putrid curd would be the right name for Limburger and fromage de Brix. Vegetarians of the Lankester school object to milk and butter on account of the spurious stuff that is often foisted upon the market under those names, but mild-tasted aliments can hardly be adulterated with very injurious substances; a little tallow, oleomargarine, or even lard, mixed with butter, and as such again mixed with a tenfold quantity of farinaceous food, can only affect the most delicate constitutions to any appreciable degree, and certainly not more than the small percentage of alum we often eat with our daily bread. Comparatively speaking, such things are the veriest trifles, and we can not afford to fight gnats while we are beset by a swarm of vampires. We have dietetic exquisites who would shudder at the idea of raising their biscuits with brewer's yeast instead of bicarbonate of soda, but do not hesitate to sandwich that same bread with strong cheese and pork-sausage; or pity the wretch whose poverty consents to North Carolina apple-jack, while they sip a *petite verre* of aromatic schiedam. That kind of purism often reminds me of the fastidiousness of Heinrich Heine's Mandarin convict, who insists on being thrashed with a perfumed bamboo, "but would have been shocked at a less fragrant hiding."

All kinds of fat ("non-nitrogenous" aliments), including butter and cream, are more digestible in winter than in summer time. Cold air is a peptic stimulant, and neutralizes the calorific effect of a non-nitrogenous diet, while fresh tree-fruits and berries counteract an excess of atmospheric heat, and thus, by an admirable provision of Nature, the seasons themselves furnish us the food most adapted to the preservation of the right medium temperature of the system. Preserved fruits (raisins, dried figs and apples, etc.) lose much of their acidity, and thus become less refreshing, but not less nutritive, at the very time when the latter property is the more important one. Cow's-milk, on the other hand, grows richer in winter-time, and this self-adaptation of their food to the varying demands of the seasons enables the inhabitants of such countries as Italy and Mexico to subsist all the year round on an almost uniform diet. But in a climate of such thermal extremes as ours it would be the best plan to vary our regimen with the weather, and, above all, to adopt a special summer diet, since the consequences of our present culinary abuses are far less baneful in January than in July. Even in mid-winter our compounds of steaming and greasy viands with hot spices severely strain the tolerance of a youthful stomach; but, when the dog-star adds its fervid influence, the demand for refrigerating food becomes so imperative that no forensic eloquence would persuade me to convict a city lad for hooking watermelons. Where fruit is cheap the *paterfamilias* should keep a storeroom full of summer apples, and leave the key in the door—it will obviate costiveness and midnight excursions. From May to September fresh fruit ought to form the staple of our diet, and the noonday meal at least should consist of cold dishes, cold apple-pudding with sweet milk and whipped eggs, or strawberries with bread, cream, and sugar. The Romans of the republican age broke their fast with a biscuit and a fig or two, and took their principal meal in the cool of the evening. In their application of the word, a frugal diet meant quite literally a diet of tree-fruits, and that our primogenitor was a frugivorous creature is the one point in which the Darwinian genesis agrees with the Mosaic version.

Dr. Alcott holds that a man might live and thrive on an exclusive diet of well-selected fruits, and I agree with him if he includes olives and oily nuts, for no assumption in dietetics is more gratuitous than the idea that a frequent use of flesh-food is indispensable to the preservation of human health. Meat is certainly not our *natural* food. The structure of our teeth, our digestive apparatus, and our hands, proves *a priori* that the physical organization of man is that of a frugivorous animal. So do our instincts. Accustom a child to a diet of milk, bread, and meat; never let him see a fruit, nor mention the existence of such a thing; then take him to an orchard, and see how quick his instinct will tell him what apples are good for. Turn him loose among a herd of lambs and kids: he will play with them as a fellow-vege-

tarian. In a slaughter-house the sight of gory carcasses and puddles of blood will excite him with a *horror naturalis*. The same sight would excite the *appetite* of the omnivorous pig as well as of the carnivorous puppy. Artificial preparation, spices, etc., may disguise the natural taste of meat, as of coffee or wine, but they will not alter its effect upon the animal system. The flesh-food fallacy, like other errors of the civilized nations, has found plausible defenders, but their principal argument is clearly based on a misunderstood fact. The delusion originated in England, where the *physique* of the beef-fed and rubicund Saxon squire contrasts strongly with that of the potato-fed Celtic laborer. What this really proves is merely that a mixed diet is superior to a diet of starch and water, for the North-Irish dairyman, who adds milk and butter to his starch, outweighs and outlives the rubicund squire. The matter is this: In a cold climate we can not thrive without a modicum of fat, but that fat need not come from slaughtered animals. In a colder country than England the East-Russian peasant, remarkable for his robust health and longevity, subsists on cabbage-soup, rye bread, and vegetable oils. In a colder country than England the Gothenburg shepherds live chiefly on milk, barley-bread, and esculent roots. The strongest men of the three manliest races of the present world are non-carnivorous: the Turanian mountaineers of Daghestan and Lesghia, the Mandingo tribes of Senegambia, and the Schleswig-Holstein *Bauern*, who furnish the heaviest cuirassiers for the Prussian army and the ablest seamen for the Hamburg navy. Nor is it true that flesh is an indispensable, or even the best, brain-food. Pythagoras, Plato, Seneca, Paracelsus, Spinoza, Peter Bayle, and Shelley were vegetarians; so were Franklin and Lord Byron in their best years. Newton, while engaged in writing his "Principia" and "Quadrature of Curves," abstained entirely from animal food, which he had found by experience to be unpropitious to severe mental application. The ablest modern physiologists incline to the same opinion. "I use animal food because I have not the opportunity to choose my diet," says Professor Welch, of Yale, "but whenever I have abstained from it, I have found my health mentally, morally, and physically better."

Though a vegetarian on principle, I have eaten various kinds of flesh as a physiological experiment, and have often observed the influence of animal food upon children and invalids, and I have found that a pound of boiled beef or eight ounces of lean pork, after a month's abstinence from all flesh-food, will infallibly produce some or all of the following unmistakable effects: a gastric uneasiness, akin to the incipient operation of certain emetics; distressing dreams, restlessness, and a peculiar mood which I might describe as a promiscuous pessimism, a feeling of general irritation and resentment. I have also noticed that flesh-food tends to check intellectual activity, not so much by making us averse to all mental occupations as by muddling what phrenologists call the *perceptives*. By its continued use children

gradually lose their native brightness as well as their amiable temper.

But the same observations oblige me to say that its deleterious *physical* effects have often been considerably overrated. The gastric uneasiness, even after a hearty meal of meat (fat pork, perhaps, excepted), yields readily to exercise in open air. Meat does not interfere with the digestion of other food, and, above all, it produces no ruinous after-effects; its frequent use rarely becomes a morbid necessity. Besides, flesh undoubtedly contains many nutritive elements, though in a less desirable form than we might find them in vegetable substances. By dint of practice the system can be got to accept part of its nutriment in that form, and if we are reduced to the choice of starving on starch and watery herbs, or getting fat in an abnormal way, the latter is clearly the preferable alternative. As a rule, though, children during their school years had better stick to dairy products, farinaceous preparations, and fruit; hot-headed boys, especially, can be more effectually cured with cow's-milk than with a cow-hide.

The objections to flesh-food, however, do not apply to eggs, and not in the same degree to mollusks and crustaceans. On the banks of the Essequibo, in eastern Venezuela, I have seen troops of capuchin monkeys (*Cebus paniscus*) engaged in catching crabs, though in captivity those same relatives of ours would rather starve than touch a piece of beef. The dog-headed baboon visits the seashore in search of mollusks, and the South American marmoset, like John the Baptist, delights in grasshoppers and wild honey, though otherwise a strict vegetarian. The mediæval distinction between flesh and fish is not wholly gratuitous, either; carp, trout, and their congeners are, happily, almost as digestible as potatoes, for it would be a hopeless undertaking to dissuade a young Walton from boiling and devouring his first string of perch. On journeys, especially in cold weather, children may be occasionally indulged in such wayside delicacies as codfish-balls, oiled sardines, and ham-sandwiches.

## THE SABBATH.

By Professor JOHN TYNDALL, F. R. S.

II.

THE moods of the times—the "climates of opinion," as Glanvil calls them—have also to be considered in imposing disciplines which affect the public. For the ages, like the individual, have their periods of mirth and earnestness, of cheerfulness and gloom. From this point of view a better case might be made out for the early Sabbatarians than for their survivals at the present day. Sunday sports

had grown barbarous; bull- and bear-baiting, interludes, and bowling were reckoned among them, and the more earnest spirits longed not only to promote edification but to curb excess. Sabbatarianism, therefore, though opposed, made rapid progress. Its opponents did what religious parties, when in power, always do—exercised that power tyrannically. They invoked the arm of the flesh to suppress or change conviction. In 1618 James I published a declaration, known afterward as "The Book of Sports," because it had reference to Sunday recreations. Puritan magistrates had interfered with the innocent amusements of the people, and the King wished to insure their being permitted after divine service to those who desired them; but not enjoined upon those who did not. Coarser sports, and sports tending to immorality, were prohibited. Charles I renewed the declaration of his father. Not content, however, with expressing his royal pleasure—not content with restraining the arbitrary civil magistrate—the King decreed that the declaration should be published "through all the parish churches," the bishops in their respective dioceses being made the vehicles of the royal command. Defensible in itself, the declaration thus became an instrument of oppression. The High Church party, headed by Archbishop Laud, forced the reading of the documents on men whose consciences recoiled from the act. "The precise clergy," as Hallam calls them, refused in general to comply, and were suspended or deprived in consequence. "But," adds Hallam, "mankind loves sport as little as prayer by compulsion; and the immediate effect of the King's declaration was to produce a far more scrupulous abstinence from diversions on Sundays than had been practiced before."

The Puritans, when they came into power, followed the evil example of their predecessors. They, the champions of religious freedom, showed that they could, in their turn, deprive their antagonists of their benefices, fine them, burn their books by the common hangman, and compel them to read from the pulpit things of which they disapproved. On this point Bishop Heber makes some excellent remarks. "Much," he says, "as each religious party in its turn had suffered from persecution, and loudly and bitterly as each had, in its own particular instance, complained of the severities exercised against its members, no party had yet been found to perceive the great wickedness of persecution in the abstract, or the moral unfitness of temporal punishment as an engine of religious controversy." In a very different strain writes the Dr. Bownd who has been already referred to as a precursor of Puritanism. He is so sure of his "doxy" that he will unflinchingly make others bow to it. "It behooveth," he says, "all kings, princes, and rulers that profess the true religion, to enact such laws, and to see them diligently executed, whereby the honor of God in hallowing these days might be maintained. And, indeed, this is the chiefest end of all government, that men might not profess what re-

ligion they list, and serve God after what manner it pleaseth them best, but that the parts of God's true worship [Bowndean worship] might be set up everywhere, and all men compelled to stoop unto it."

There is, it must be admitted, a sad logical consistency in the mode of action advocated by Dr. Bownd and deprecated by Bishop Heber. As long as men hold that there is a hell to be shunned, they seem logically warranted in treating lightly the claims of religious liberty upon earth. They dare not tolerate a freedom whose end they believe to be eternal perdition. Cruel they may be for the moment, but a passing pang vanishes when compared with an eternity of pain. Unreligious men might call it hallucination, but if I accept undoubtingly the doctrine of eternal punishment, then, whatever society may think of my act, I am self-justified not only in "letting" but in destroying that which I hold dearest, if I believe it to be thereby stopped in its progress to the fires of hell. Hence, granting the assumptions common to both, the persecution of Puritans by High Churchmen, and of High Churchmen by Puritans, had a basis in reason. I do not think the question can be decided on *a priori* grounds, as Bishop Heber seemed to suppose. It is not the abstract wickedness of persecution, so much as our experience of its results, that causes us to set our faces against it. It has been tried, and found the most ghastly of failures. This experimental fact overwhelms the plausibilities of logic, and renders persecution, save in its meaner and stealthier aspects, in our day impossible.

The combat over Sunday continued, the Sabbatarians continually gaining ground. In 1643 the divines who drew up the famous document known as the Westminster Confession began their sittings in Henry VII's Chapel. Milton thought lightly of these divines, who, he said, were sometimes chosen by the whim of members of Parliament; but the famous Puritan, Baxter, extolled them for their learning, godliness, and ministerial abilities. A journal of their earlier proceedings was kept by one of their members. On the 13th of November, 1644, he records the occurrence of "a large debate" on the sanctification of the Lord's day. After fixing the introductory phraseology, the assembly proceeded to consider the second proposition, "To abstain from all unnecessary labors, worldly sports, and recreations." It was debated whether "worldly thoughts" should not be added. "This was scrupulous," says the *naïve* journalist, "whether we should not be a scorn to go about to bind men's thoughts, but at last it was concluded upon to be added, both for the more piety and for that the fourth command includes it." The question of Sunday cookery was then discussed and settled; and, as regards public worship, it was decreed "that all the people meet so timely that the whole congregation be present at the beginning, and not depart until after the blessing. That what time is vacant between or after the solemn meetings of the congregation be spent in reading, meditation, repetition of sermons,"

etc. These holy men were full of that strength already referred to as imparted by faith. They needed no natural joy to brighten their lives, mirth being displaced by religious exaltation. They erred, however, in making themselves a measure for the world at large, and insured the overthrow of their cause by drawing too heavily upon average human nature. "This much," says Hallam, "is certain, that when the Puritan party employed their authority in proscribing all diversions, and enforcing all the Jewish rigor about the Sabbath, they rendered their own yoke intolerable to the young and gay; nor did any other cause, perhaps, so materially contribute to bring about the Restoration."

In 1646, the "Confession" being agreed upon, it was presented to Parliament, which, in 1648, accepted and published its doctrinal portion. There was no lack of definiteness in the Assembly's statements. They spoke as confidently of the divine enactments as if each member had been personally privy to the counsels of the Most High. When Luther in the Castle of Marburg had had enough of the arguments of Zuinglius on the "real presence," he is said to have ended the controversy by taking up a bit of chalk and writing firmly and finally upon the table, "*Hoc est corpus meum.*" Equally downright and definite were the divines at Westminster. They were modest in offering their conclusions to Parliament as "humble advice," but there was no flicker of doubt either in their theology or their cosmology. "From the beginning of the world," they say, "to the resurrection of Christ the last day of the week was kept holy as a Sabbath"; while from the resurrection it "was changed into the first day of the week, which in Scripture is called the Lord's day, and is to be continued to the end of the world as the Christian Sabbath." The notions of the divines regarding the "beginning and the end" of the world were primitive but decided. An ancient philosopher was once mobbed for venturing the extravagant opinion that the sun, which appeared to be a circle less than a yard in diameter, might really be as large as the whole country of Greece. Imagine a man with the knowledge of a modern geologist uttering his blasphemies among these Westminster divines! "It pleased God," they continue, "at the beginning, to create, or make of nothing, the world and all things therein, whether visible or invisible, in the space of six days, and all very good." Judged from our present scientific standpoint, this, of course, is mere nonsense. But the calling of it by this name does not exhaust the question. The real point of interest to me, I confess, is not the cosmological errors of the Assembly, but the hold which theology has taken of the human mind, and which enables it to survive the ruin of what was long deemed essential to its stability. On this question of "essentials" the gravest mistakes are constantly made. Save as a passing form, no part of objective religion is essential. Religion lives not by the force and aid of dogma, but because it is ingrained in the nature of man. To draw

a metaphor from metallurgy, the molds have been broken and reconstructed over and over again, but the molten ore abides in the ladle of humanity. An influence so deep and permanent is not likely soon to disappear; but of the future form of religion little can be predicted. Its main concern may possibly be to purify, elevate, and brighten the life that now is, instead of treating it as the more or less dismal vestibule of a life that is to come.

The term "nonsense," which has been just applied to the views of creation enunciated by the Westminster Assembly, was used, as already stated, in reference to our present knowledge and not to the knowledge of three or four centuries ago. To most people the earth was at that time all in all; the sun and moon and stars being set in heaven merely to furnish lamplight to our planet. But though in relation to the heavenly bodies the earth's position and importance were thus exaggerated, very inadequate and erroneous notions were entertained regarding the shape and magnitude of the earth itself. Theologians were horrified when first informed that our planet was a sphere. The question of antipodes exercised them for a long time, most of them pouring ridicule on the idea that men could exist with their feet turned toward us, and with their heads pointing downward. I think it is Sir George Airy who refers to the case of an over-curious individual asking what we should see if we went to the edge of the world and looked over. That the earth was a flat surface on which the sky rested was the belief entertained by the founders of all our great religious systems. Even liberal Protestant theologians stigmatized the Copernican theory as being "built on fallible phenomena and advanced by many arbitrary assumptions against evident testimonies of Scripture."* Newton finally placed his intellectual crowbar beneath these ancient notions, and heaved them into irretrievable ruin.

Then it was that penetrating minds, seeing the nature of the change wrought by the new astronomy in our conceptions of the universe, also discerned the difficulty, if not the impossibility, of accepting literally the Mosaic account of creation. They did not reject it, but they assigned to it a meaning entirely new. Dr. Samuel Clarke, who was the personal friend of Newton and a supporter of his theory, threw out the idea that "possibly the six days of creation might be a typical representation of some greater periods." Clarke's contemporary, Dr. Thomas Burnet, wrote with greater decision in the same strain. The Sabbath being regarded as a shadow or type of that heavenly repose which the righteous will enjoy when this world has passed away, "so these six days of creation are so many periods or millenniums for which the world and the toils and labors of our present state are destined to endure."† The Mosaic account was thus reduced

* Such was the view of Dr. John Owen, who is described by Cox as "the most eminent of the Independent divines."

† Cox, vol. ii, p. 211, note.

to a poetic myth—a view which afterward found expression in the vast reveries of Hugh Miller. But if this symbolic interpretation, which is now generally accepted, be the true one, what becomes of the Sabbath-day? It is absolutely without ecclesiastical meaning; and the man who was executed for gathering sticks on that day must be regarded as the victim of a rude legal rendering of a religious epic.

There were many minor offshoots of discussion from the great central controversy. Bishop Horsley had defined a day "as consisting of one evening and one morning, or, as the Hebrew words literally import, of the decay of light and the return of it." But what then, it was asked, becomes of the Sabbath in the Arctic regions, where light takes six months to "decay," and as long to "return"? Differences of longitude, moreover, render the observance of the Sabbath at the same hours impossible. To some people such questions might appear trifling; to others they were of the gravest import. Whether the Sabbath should stretch from sunset to sunset, or from midnight to midnight, was also a subject of discussion. Voices, moreover, were heard refusing to acknowledge the propriety of the change from Saturday to Sunday, and the doctrine of Seventh-day observance was afterward represented by a sect.* The earth's sphericity and rotation, which had at first been received with such affright, came eventually to the aid of those afflicted with qualms and difficulties regarding the respective claims of Saturday and Sunday. The sun apparently moves from east to west. Suppose, then, we start on a voyage round the world in a westerly direction. In doing so we sail away, as it were, from the sun, which follows and periodically overtakes us, reaching the meridian of our ship each succeeding day somewhat later than if we stood still. For every 15° of longitude traversed by the vessel the sun will be exactly an hour late; and after the ship has traversed twenty-four times 15°, or 360°, that is to say, the entire circle of the earth, the sun will be exactly a day behind. Here, then, is the expedient suggested by Dr. Wallis, F. R. S., Savilian Professor of Geometry in the University of Oxford, to quiet the minds of those in doubt regarding Saturday observance. He recommends them to make a voyage round the world, as Sir Francis Drake did, "going out of the Atlantic Ocean westward by the Straits of Magellan to the East Indies, and then from the east, returning by the Cape of Good Hope homeward, and let them keep their Saturday-Sabbath all the

* Theophilus Brabourne, a sturdy Puritan minister of Norfolk, whom Cox regards as the founder of this sect, thus argued the question in 1628: "And now let me propound unto your choice these two days: the Sabbath-day on Saturday or the Lord's day on Sunday; and keep whether of the twain you shall in conscience find the more safe. If you keep the Lord's day, but profane the Sabbath-day, you walk in great danger and peril (to say the least) of transgressing one of God's eternal and inviolable laws—the fourth commandment. But, on the other side, if you keep the Sabbath-day, though you profane the Lord's day, you are out of all gunshot and danger, for so you transgress no law at all, since neither Christ nor his apostles did ever leave any law for it."

way. When they come home to England they will find their Saturday to fall upon our Sunday, and they may thenceforth continue to observe their Saturday-Sabbath on the same day with us!"

Large and liberal minds were drawn into this Sabbatarian conflict, but they were not the majority. Between the booming of the bigger guns we have an incessant clatter of small-arms. We ought not to judge superior men without reference to the spirit of their age. This is an influence from which they can not escape, and so far as it extenuates their errors it ought to be pleaded in their favor. Even the atrocities of the individual excite less abhorrence when they are seen to be the outgrowth of his time. But the most fatal error that could be committed by the leaders of religious thought is the attempt to force into their own age conceptions which have lived their life, and come to their natural end, in preceding ages. History is the record of a vast experimental investigation—of a search by man after the best conditions of existence. The Puritan attempt was a grand experiment. It had to be made. Sooner or later the question must have forced itself upon earnest believers possessed of power, Is it not possible to rule the world in accordance with the wishes of God as revealed in the Bible? Is it not possible to make human life the copy of a divine pattern? The question could only have occurred in the first instance to the more exalted minds. But, instead of working upon the inner forces and convictions of men, legislation presented itself as a speedier way to the attainment of the desired end. To legislation, therefore, the Puritans resorted. Instead of guiding, they repressed, and thus pitted themselves against the unconquerable impulses of human nature. Believing that nature to be depraved, they felt themselves logically warranted in putting it in irons. But they failed; and their failure ought to be a warning to their successors.

Another error, of a far graver character than that just noticed, may receive a passing mention here. At the time when the Sabbath controversy was hottest, and the arm of the law enforcing the claims of the Sabbath strongest and most unsparing, another subject profoundly stirred the religious mind of Scotland. A grave and serious nation, believing intensely in its Bible, found therein recorded the edicts of the Almighty against witches, wizards, and familiar spirits, and were taught by their clergy that such edicts still held good. The same belief had overspread the rest of Christendom, but in Scotland it was intensified by the rule of Puritanism and the natural earnestness of the people. I have given you a sample of the devilish cruelties practiced on the Christians at Smyrna. These tortures were far less shocking than those inflicted upon witches in Scotland. I say less shocking, because the victims at Smyrna courted martyrdom. They counted the sufferings of this present time as not worthy to be compared with the glory to be revealed; while the sufferers for witchcraft, in the midst of all their agonies, felt themselves God-forsaken, and

saw before them instead of the glories of heaven the infinite tortures of hell. Not to the fall of Sarmatia, but to the treatment of witches in the seventeenth century, ought to be applied the words of your poet Campbell:

"Oh! bloodiest picture in the book of time!"

The mind sits in sackcloth and ashes while contemplating the scenes so powerfully described by Mr. Lecky in his chapter on "Magic and Witchcraft." But I will dwell no further upon these tragedies than to point out how terrible are the errors which our clergy may commit after they have once subscribed to the creed and laws of Judaism, and constituted themselves the legal exponents and interpreters of those laws.*

Turning over the leaves of the Pentateuch, where God's alleged dealings with the Israelites are recorded, it strikes one with amazement that such writings should be considered binding upon us. The overmastering strength of habit, the power of early education—possibly a defiance of the claims of reason involved in the very constitution of the mental organ—are illustrated by the fact that learned men are still to be found willing to devote their time and endowments to these writings, under the assumption that they are not human but divine. As an ancient book, claiming the same origin as other books, the Old Testament is without a rival, but its unnatural exaltation provokes recoil and rejection. Leviticus, for example, when read in the light of its own age, is full of interest and instruction. We see there described the efforts of the best men then existing to civilize the rude society around them. Violence is restrained by violence medicinally applied. Passion is checked, truth and justice are extolled, and all in a manner suited to the needs of a barbarian host. But read in the light of our age, its conceptions of the Deity are seen to be shockingly mean, and many of its ordinances brutal. Foolishness is far too weak a word to apply to any attempt to force upon a scientific age the edicts of a Jewish law-giver. The doom of such an attempt is sure; and, if the destruction of things really precious should be involved in its failure, the blame will justly be ascribed to those who obstinately persisted in the attempt. Let us, then, cherish our Sunday as an inheritance derived from the wisdom of the past; but let it be understood that we cherish it because it is in principle reasonable and in practice salutary. Let us uphold it, because it commends itself to that "light of nature" which, despite the catastrophe in Eden, the most famous theologians mention with respect, and not because it is enjoined by the thunders of Sinai. We have surely heard enough of divine sanctions founded upon myths which, however beautiful and touching when regarded from the proper point of view, are seen, when cited

* The sufferings of reputed witches in the seventeenth century, as well as those of the early Christians, might be traced to panics and passions similar in kind to those which produced the atrocities of the Reign of Terror in France.

for our guidance as matters of fact, to offer warrant and condonation for the greatest crimes, or to sink to the level of the most palpable absurdities.*

In this, as in all other theological discussions, it is interesting to note how character colors religious feeling and conduct. The reception into Christ's kingdom has been emphatically described as being born again. A certain likeness of feature among Christians ought, one would think, to result from a common spiritual parentage. But the likeness is not observed. Christian communities embrace some of the loftiest and many of the lowest of mankind. It may be urged that the lofty ones only are truly religious. To this it is to be replied that the others are often as religious as their natures permit them to be. *Character* is here the overmastering force. That religion should influence life in a high way implies the preëxistence of natural dignity. This is the mordant which fixes the religious dye. He who is capable of feeling the finer glow of religion would possess a substratum available for all the relations of life, even if his religion were taken away. Religion, on the other hand, does not charm away malice, or make good defects of character. I have already spoken of persecution in its meaner forms. On the lower levels of theological warfare such are commonly resorted to. If you reject a dogma on intellectual grounds, it is because there is a screw loose in your morality; some personal sin besets and blinds you; the intellect is captive to a corrupt heart. Thus good men have been often calumniated by others who were not good; thus frequently have the noble become a target for the wicked and the mean. With the advance of public intelligence the day of such assailants is happily drawing to a close.

These reflections, which connect themselves with reminiscences outside the Sabbath controversy, have been more immediately prompted by the aspersions cast by certain Sabbatarians upon those who differ from them. Mr. Cox notices and reproves some of these. According to the Scottish Sabbath Alliance, for example, all who say that the Sabbath was an exclusively Jewish institution, including, be it noted, such men as Jeremy Taylor and Milton, "clearly prove either their *dishonesty* or ignorance, or inability to comprehend a very plain and simple subject." This becomes real humor when we compare the speakers with the persons spoken of. A distinguished English dissenter, who deals in a lustrous but rather cloudy logic, declares that whoever asks demonstration of the divine appointment of the Christian Sabbath "is

* Melanchthon writes finely thus: "Wherefore our decision is this: that those precepts which learned men have committed to writing, transcribing them from the common reason and common feelings of human nature, are to be accounted as no less divine than those contained in the tables of Moses."—(Dugald Stewart's translation.) Hengstenberg quotes from the same reformer as follows: "The law of Moses is not binding upon us, though some things which the law contains are binding, because they coincide with the law of nature."—(See Cox, vol. i, p. 389.) The Catechism of the Council of Trent expresses a similar view. There are, then, "data of ethics" over and above the revealed ones.

blinded *by a moral cause* to those exquisite pencilings, to those unobtruded vestiges, which furnish their clearest testimony to this institute." A third writer charitably professes his readiness "to admit, in reference to this and many other duties, that it is quite a possible thing for a mind that is desirous of *evading the evidence* regarding it to succeed in doing so." A fourth luminary, whose knowledge obviously extends to the mind and methods of the Almighty, exclaims, "Is it not a principle of God's Word in many cases to give enough and no more—to satisfy the devout, not to overpower the *uncandid?*" It is of course as easy as it is immoral to argue thus; but the day is fast approaching when the most atrabilious presbyter will not venture to use such language. Let us contrast with it the utterance of a naturally sweet and wholesome mind. "Since all Jewish festivals, new moons, and Sabbaths," says the celebrated Dr. Isaac Watts, "are abolished by St. Paul's authority; since the religious observation of days in the fourteenth chapter to the Romans, in general, is represented as a matter of doubtful disputation; since the observation of the Lord's day is not built upon any express or plain institution by Christ or his apos tles in the New Testament, but rather on examples and probable inferences, and on the reasons and relations of things—I can never pronounce anything hard or severe upon any fellow-Christian who maintains real piety in heart and life, though his opinion on this subject may be very different from mine." Thus through the theologian radiates the gentleman.

Up to the end of the eighteenth century the catalogue of Mr. Cox embraces three hundred and twenty volumes and publications. It is a monument of patient labor; while the remarks of the writer, which are distributed throughout the catalogue, illustrate both his intellectual penetration and his reverent cast of mind. He wrought hard and worthily with a pure and noble aim. I had the pleasure of meeting Mr. Cox at Dundee in 1867, when the British Association met there, and I could then discern the earnestness with which he desired to see his countrymen relieved from the Sabbath incubus, and at the same time the moderation and care for the feelings of others with which he advocated his views. He has also given us a rapid "Sketch of the Chief Controversies about the Sabbath in the Nineteenth Century." The sketch is more compressed than the catalogue, and the changes of thought in passing from author to author, being more rapid, are more bewildering. It is to a great extent what I have already called a clatter of small-arms, mingled with the occasional discharges of mightier guns. One thing is noticeable and regrettable in these discussions, namely, the unwise and undiscriminating way in which different Sunday occupations are classed together and condemned. Bishop Blomfield, for example, seriously injures his case when he places drinking in gin-shops and sailing in steamboats in the same category. I remember some years ago standing by the Thames at Putney with my

lamented friend Dr. Bence Jones, when a steamboat on the river, with its living freight, passed us. Practically acquainted with the moral and physical influence of pure oxygen, my friend exclaimed, "What a blessing for these people to be able thus to escape from London into the fresh air of the country!" I hold the physician to have been right, and, with all respect, the Bishop to have been wrong.

Bishop Blomfield also condemns resorting to tea-gardens on Sunday. But we may be sure that it is not the gardens, but the minds which the people bring to them, which produce disorder. These minds possess the culture of the city, to which the Bishop seems disposed to confine them. Wisely and soberly conducted—and it is perfectly possible to conduct them wisely and soberly—such places might be converted into aids toward a life which the Bishop would commend. Purification and improvement are often possible where extinction is neither possible nor desirable. I have spent many a Sunday afternoon in the public gardens of the little university town of Marburg, in the company of intellectual men and cultivated women, without observing a single occurrence which, as regards morality, might not be permitted in the Bishop's drawing-room. I will add to this another observation made at Dresden on a Sunday after the suppression of the insurrection by the Prussian soldiery in 1849. The victorious troops were encamped on the banks of the Elbe, and this is how they occupied themselves: Some were engaged in physical games and exercises which in England would be considered innocent in the extreme; some were conversing sociably; some singing the songs of Uhland, while others, from elevated platforms, recited to listening groups poems and passages from Goethe and Schiller. Through this crowd of military men passed and repassed the girls of the city, linked together with their arms round each other's necks. During hours of observation, I heard no word which was unfit for a modest ear; while from beginning to end I failed to notice a single case of intoxication.*

Here we touch the core of the whole matter—the appeal to experience. Sabbatical rigor has been tried, and the question is, Have its results been so conducive to good morals and national happiness as to render criminal every attempt to modify it? The advances made in all kinds of knowledge in this our age are known to be enormous; and the public desire for instruction, which the intellectual triumphs of the time naturally and inevitably arouse, is commensurate with the growth of knowledge. Must this desire, which is the motive power of all real and healthy progress, be quenched or left unsatisfied, lest Sunday observances, unknown to the early Christians, repudiated by the heroes of the Reformation, and insisted upon for the first time during a period of national gloom and suffering in the seventeenth century, should be

* The late Mr. Joseph Kay, as Traveling Bachelor of the University of Cambridge, has borne strong and earnest testimony to the "humanizing and civilizing influence" of the Sunday recreations of the German people.

interfered with? To justify this position the demonstration of the success of Sabbatarianism must be complete. Is it so? Are we so much better than other nations who have neglected to adopt our rules, that we can point to the working of these rules in the past as a conclusive reason for maintaining them immovable in the future? The answer must be, No. My Sabbatarian friends, you have no ground to stand upon. I say friends, for I would far rather have you as friends than as enemies—far rather see you converted than annihilated. You possess a strength and earnestness with which the world can not dispense; but, to be productive of anything permanently good, that strength and earnestness must build upon the sure foundation of human nature. This is that law of the universe spoken of so frequently by your illustrious countryman, Mr. Carlyle, to quarrel with which is to provoke and precipitate ruin. Join with us, then, in our endeavors to turn our Sundays to better account. Back with your support the moderate and considerate demands of the Sunday Society, which scrupulously avoids interfering with the hours devoted by common consent to public worship. Offer the museum, the picture-gallery, and the public garden as competitors to the public-house. By so doing you will fall in with the spirit of your time, and row with, instead of against, the resistless current along which man is borne to his destiny.

Most of you here are Liberals; perhaps Radicals, perhaps even Democrats or Republicans. I am a Conservative. The first requisite of true conservatism is foresight. Humanity grows, and foresight secures room for future expansion. In your walks in the country you sometimes see a wall built round a growing tree. So much the worse for the wall, which is sure to be rent and ruined by the energy which it opposes. We have here represented not a true, but a false and ignorant conservatism. The real conservative looks ahead and prepares for the inevitable. He forestalls revolution by securing, in due time, sufficient amplitude for the national vibrations. He is a wrong-headed statesman who imposes his notions, however right in the abstract, on a nation unprepared for them. He is no statesman at all who, without seeking to interpret and guide it in advance, merely waits for the more or less coarse expression of the popular will, and then constitutes himself its vehicle. *Untimeliness* is sure to be the characteristic of the work of such a statesman. In virtue of the position which he occupies, his knowledge and insight ought to be in advance of the public knowledge and insight; and his action, in like degree, ought to precede and inform public action. This is what I want my Sabbatarian friends to bear in mind. If they look abroad from the vantage-ground which they occupy, they can hardly fail to discern that the intellect of this country is gradually ranging itself upon our side. Statesmen, clergymen, philosophers, and moralists are joining our standard. Whether, therefore, those to whom I appeal hear, or whether they forbear, we are sure to unlock, for the public

good, the doors of the museums and galleries which we have purchased, and for the maintenance of which we pay. But I would have them not only prepare for the coming change, but to aid and further it by anticipation. They will thus, in a new fashion, "dish the Whigs," prove themselves men of foresight and common sense, and obtain a fresh lease of the respect of the community.

As the years roll by, the term "materialist" will lose more and more of its evil connotation; for it will be more and more seen and acknowledged that the true spiritual nature of man is bound up with his material condition. Wholesome food, pure air, cleanliness—hard work if you will, but also fair rest and recreation—these are necessary not only to physical but to spiritual well-being. The seed of the spirit is cast in vain amid stones and thorns, and thus your best utterances become idle words when addressed to the acclimatized inhabitants of our slums and alleys. Drunkenness ruins the substratum of resolution. The physics of the drunkard's brain are incompatible with moral strength. Here your first care ought to be to cleanse and improve the organ. Break the sot's associations; change his environment; alter his nutrition; displace his base imaginations by thoughts drawn from the purer sources which we seek to render accessible to him. For two centuries, I am told, the Scottish clergy have proclaimed walking on Sunday to be an act of "Heaven-daring profaneness—an impious encroachment on the inalienable prerogative of the Lord God." Such language is now out of date. If we could establish Sunday tramways between our dens of filth and iniquity and the nearest green fields, we should, in so doing, be preaching a true gospel. And not only the denizens of our slums, but the proprietors of our factories and counting-houses, might perhaps be none the worse for an occasional excursion in the company of those whom they employ. A most blessed influence would also be shed upon the clergy if they were enabled from time to time to change their "sloth urbane" for healthy action on heath or mountain. Baxter was well aware of the soothing influence of fields, and countries, and walks, and gardens on a fretted brain. Jeremy Taylor showed a profound knowledge of human nature when he wrote thus: "It is certain that all which can innocently make a man cheerful, does also make him charitable. For grief, and age, and sickness, and weariness, these are peevish and troublesome; but mirth and cheerfulness are content, and civil, and compliant, and communicative, and love to do good, and swell up to felicity only upon the wings of charity. Upon this account, here is pleasure enough for a Christian at present; and if a facete discourse, and an amicable friendly mirth, can refresh the spirit and take it off from the vile temptation of peevish, despairing, uncomplying melancholy, it must needs be innocent and commendable." I do not know whether you ever read Thomas Hood's "Ode to Rae Wilson," with an extract from which I will close this address. Hood was a humorist, and to some of our graver theologians

might appear a mere feather-head. But those who have read his more serious works will have discerned in him a vein of deep poetic pathos. I hardly know anything finer than the apostrophe in which he turns from those

> "That bid you balk
> A Sunday walk,
> And shun God's work as you should shun your own"—

to the description of what Sunday might be, and is, to him who is competent to enjoy it aright :

> "Thrice blessed, rather, is the man, with whom
> The gracious prodigality of nature,
> The balm, the bliss, the beauty, and the bloom,
> The bounteous providence in every feature,
> Recall the good Creator to his creature,
> Making all earth a fane, all heaven its dome!
> To *his* tuned spirit the wild heather-bells
> Ring Sabbath knells;
> The jubilate of the soaring lark
> Is chant of clerk;
> For choir, the thrush and the gregarious linnet;
> The sod's a cushion for his pious want;
> And, consecrated by the heaven within it,
> The sky-blue pool, a font.
> Each cloud-capped mountain is a holy altar;
> An organ breathes in every grove;
> And the full heart's a Psalter,
> Rich in deep hymns of gratitude and love!"

—*Nineteenth Century.*

## DOMESTIC MOTORS.

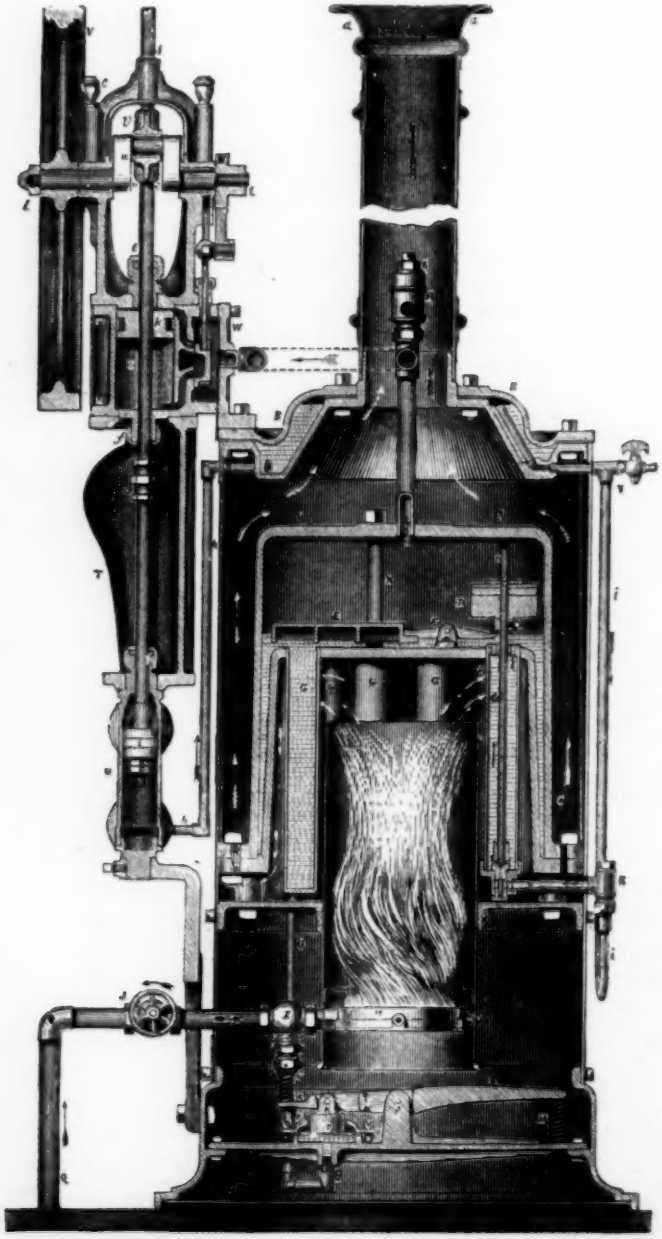
By CHARLES M. LUNGREN.

### II.—STEAM AND HOT-AIR ENGINES.

SMALL steam-engines of from two to ten horse-power are made by a number of engine-builders, and are quite extensively used. They are of varied excellence, like those of larger size, and are well enough known to need no description here. Those of powers of one horse and under suitable for use in the household, for amateurs, etc., are, however, comparatively rare. The danger of explosion, and the requirement of skilled attendants, which in cities the law in consequence imposes, have operated to prevent their use; while, on account of the but little greater cost of the larger and more serviceable machines, makers have preferred to construct the latter. Some of these small engines are, however, made, two of the best designs of which, the invention of Mr. H. S. Maxim, are shown in Figs. 4 and 5. The one illustrated in

the first engraving is constructed for pumping purposes only, and that in Fig. 5 for power. Both forms use gas in the smaller sizes, and are entirely automatic in their action. They are compact, highly finished,

FIG. 4.

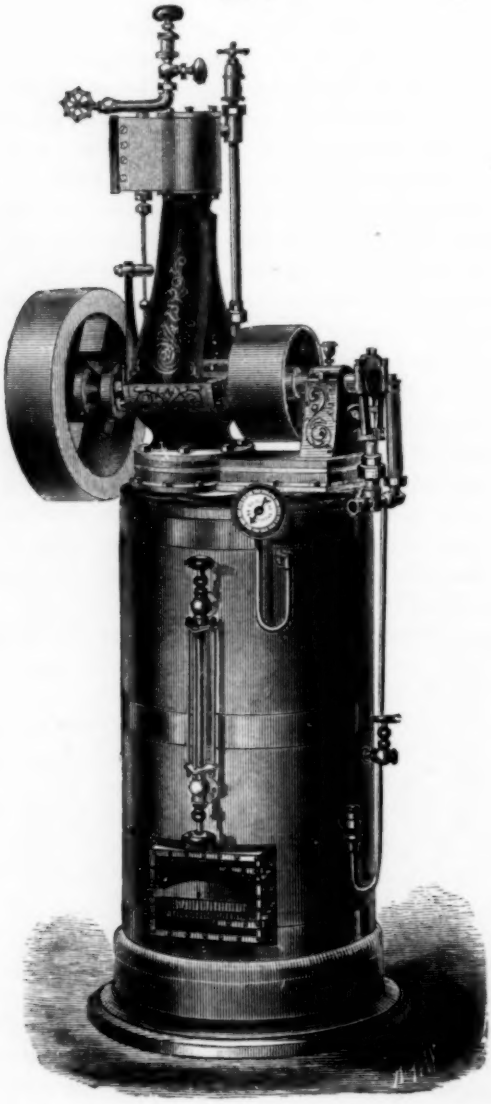


and can be used anywhere in a house without annoyance, as they run with almost no noise. They occupy but small space, the boiler-casing being in the smallest size but sixteen inches in diameter and three feet in height. The base of the machine has air-spaces to prevent the heat from burning the floor. The construction and operation of the pumping-engine will be clear from an inspection of the cut. The heater B surrounds the boiler C C, which is made with pendent water-tubes G G, among which the burning gases circulate on their way to the smoke-stack. The gas burns from a double argand burner H, the supply being automatically controlled by the steam-pressure in an ingenious manner. At I, a valve is placed in the gas-pipe which is operated by the lever *l*, the longer end of which is pressed up by the spring M. A tube, *o*, leads from the boiler to a chamber in which works the diaphragm-piston *r*, attached to the shorter end of the lever L. If the pressure in the boiler increases, it is transmitted to the piston which rises and partially closes the valve I, diminishing the supply of gas. A lessening of the boiler-pressure produces the reverse effect of increasing the gas-supply. The amount of fuel consumed is thus accurately proportioned to the amount of steam generated by the engine itself. This allows the gas to be kept burning while no work is being done, and consequently no steam used without there being the slightest danger of an explosion, a feature of great value in a power-engine when it is used intermittently, but needs to be in constant readiness. In the larger sizes in which coal is used, the fire is regulated by means of an automatic damper operated in a similar manner to the valve controlling the gas-supply.

The feeding of water to the boiler is also controlled by a very simple automatic arrangement. The feed-water chamber is placed at the top of the heater-shell, where it is exposed to the heat of the issuing products of combustion. A pipe, *h*, is open to both the pump and this chamber. So long as the feed-water heater is but partially filled, water continues to be forced into it by the pump; but, when it becomes full, no more can enter until a portion of it has passed into the boiler. The admittance to this latter is controlled by a float mechanism, E, F, D, operating a valve at the base of the boiler through the medium of the rod *o*. The float E is a flat, inverted vessel, which is partially submerged when the boiler is full. A weight, D, at the other extremity of the lever F, is then able to keep the valve closed; but, as the level of the water sinks, the float drops and the valve is opened by the rod *o*, the pressure produced by the pump forcing water from the feed-heater into the boiler. By these two devices, the one controlling the heat by the steam-pressure so as to keep that pressure constant, and the other regulating the amount of water in the boiler, this steam-engine becomes nearly as safe, and gives as little trouble, as any of the simpler forms of heat-engine using hot air or gas. For still further security a safety-valve is placed in the pipe leading from the boiler,

at A ; and in the engines using coal, the heat of which can not be so perfectly controlled as that of gas, a plug of fusible metal is set into the crown-sheet, which melts when the temperature rises above a certain point, and allows the water to flow out and extinguish the fire.

FIG. 5.

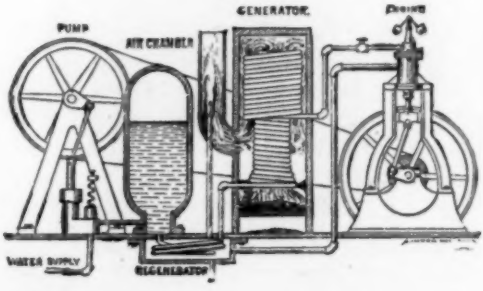


The design of the boiler of the power-engine is somewhat different from that of the pumping one, but the means of automatically regulating both the steam-pressure and the water-supply are substantially the same. This engine has in addition a very ingenious governor which acts

directly upon the point of cut-off as in the best machines of large power. It is placed inside the belt-pulley, and dispenses with the ordinary belt, thereby avoiding the danger of the engine racing through the breaking or slipping of the belt. The balls are two heavy weights revolving with the belt-pulley, and balanced by spiral springs. They are free to move in the direction of the radius of the wheel to and from the center, and, as they do so under variations of speed, they operate the cut-off mechanism in a simple manner. The working of this governor has been found very satisfactory in use, and it seems to be well suited to engines of larger power. This engine is made in sizes of one half, one, one and a half, two, and two and a half horse-power, and up to five horse, while the pumping-engine is made of a capacity of from two hundred and fifty to fifteen hundred gallons per hour, raised one hundred feet high. The former amount is pumped with an expenditure of twenty-five feet of gas an hour. These engines have been on the market some five years, and have been found very satisfactory in use.

An engine of very much smaller power, and quite novel construction, the invention of Mr. Charles Tyson, has very recently been brought out, which seems to be well adapted to driving such light machinery as sewing and knitting machines, lathes, scroll-saws, fans, coffee-mills, etc. It is quite safe, requires but little care, does not easily get out of order, and can be managed by any one capable of using a sewing-machine. It is ornamental in design and handsomely finished, fitting it to be used in any room of a dwelling that is convenient. Those at present made are of about one quarter of a man-power (one thousand foot-pounds per minute), but larger sizes, adapted to a greater range of

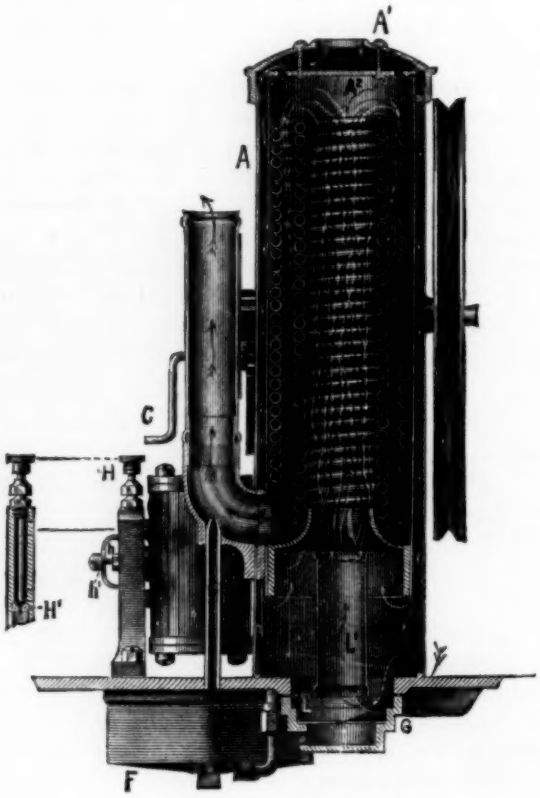
FIG. 6.




work, will probably be built should the present machine prove satisfactory in use. Gas is used as fuel, but they can be made to burn either coal, wood, or oil. The construction and method of generating steam are such that an explosion can not occur, and the steam-gauge, water-gauge, and safety-valve are therefore dispensed with, with the advantage of considerably lessening the cost. The idea carried out in the construction of this engine is that of converting the water into steam in

small amounts at a time. In the steam-engine, large or small, the whole body of water is exposed to the action of the fire, and a considerable quantity of steam is constantly generated. In this, small quantities of water are successively forced from a reservoir through coils of highly heated tubing, and there flashed into steam. A force-pump driven by the engine continually supplies water to the reservoir. The relation of the different parts of the apparatus to each other, and the working of the system, are clearly shown in Fig. 6. The long tubing, in which the water is converted into steam, leads from the air-chamber to the steam-chest of the engine. It is coiled first in a receptacle through which the exhaust steam passes, and then in the generator, where it is as completely as possible exposed to the action of the fire. In starting the engine, the fly-wheel is turned by hand, so as to produce a pressure in

FIG. 7.




the air-chamber. This forces the water into the coil, where it is rapidly converted into steam, and delivered in the steam-chest at the pressure furnished by the pump. When the engine begins running, it drives the pump and maintains the pressure. If the engine is stopped

and the fire continues to burn, the water in the coil will be forced back into the air-chamber, and the production of steam will cease.

When the water is exhausted, the engine simply stops until the supply is renewed. At the right of the pump a relief-valve is placed to limit the pressure. It is not a safety-valve, as, even if it were absent, an explosion could not occur, as the mechanism of the pump is not strong enough to produce a bursting pressure. The construction of the generator is more fully shown in Fig. 7. It consists of a cylindrical shell in which is coiled about thirty-five feet of seamless copper tubing. In the base of this is a gas-burner, L, and around it is a second shell, leaving an annular space for the entrance of air. The air is also admitted through openings at the bottom of the shell. The burning gases pass up through the center of the coils and down between the two, and out by the draught-pipe. The exhaust steam is discharged through the regenerator, where it partly heats the water in the coil, into this draught-pipe. On first lighting the gas, the cap A′ is removed and the flame allowed to burn up into the air, but as soon as the formation of steam begins the cap is replaced, and the exhaust steam then creates sufficient draught to carry the burning gases through the coils into the draught-pipe. The generator has but one fiftieth the cubical capacity of that required by an ordinary boiler to run the same engine. The engine is of the simple oscillating type, and the whole apparatus is attached to a bed-plate forming the top of a vase-shaped receptacle. Fig. 8 shows the appearance of the complete motor. In another form the vase is supported by a bracket attached to the wall instead of by the tripod. The vase is used to hold the water from which the pump supplies the reservoir. Four or five quarts of water once in as many hours is generally sufficient in the ordinary use of the machine.

Fig. 8.

The engine in this size is far from being economical, requiring twelve cubic feet of gas an hour, while it only furnishes a thirty-third of a horse-power. Efficiency, however, is not very important with such a small motor. This amount of fuel, with

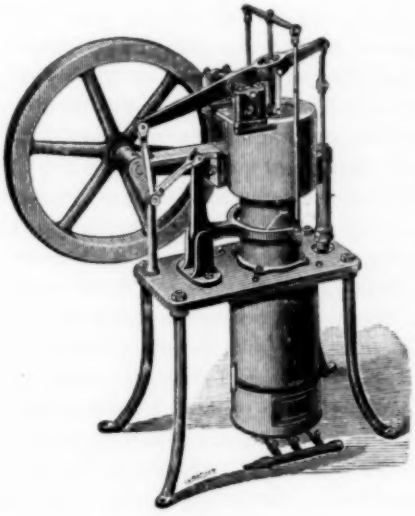
gas at two dollars per thousand, would only cost a little more than two cents an hour, which would make the expense of running a sewing-machine as commonly used inconsiderable. The first cost of the motor is low, while its simplicity of construction should render it quite durable.

The advantages possessed by engines driven by heated air over those using steam, in the matter of safety, absence of the need of skilled attendance, and a possible higher efficiency, early turned the attention of inventors toward the development of this class of motors. Promising as the field seemed, the practical realization of the hopes indulged in has been far short of expectation. The rapid alternate heating and cooling of the air, and the prevention of excessive wear due to traveling surfaces becoming highly heated, have been found to be difficult things to accomplish satisfactorily. On account of the low pressure obtained from heated air, engines of this kind have to be made of such large dimensions that there is little if any gain in compactness over the steam-engine and boiler. This greater size of the working parts also increases friction largely, so much indeed that whatever superior efficiency the hot-air engine may possess, from being able to work between greater extremes of temperature, disappears in the power required to move simply the machine itself. In large powers this engine has never yet been able to compete with the steam-engine, but in small ones it has proved to be quite an economical and serviceable motor. A number of engines of this kind have been invented at different times, and some have gone more or less largely into use. The earliest to excite interest, and to come into a limited use, was that of Rev. Dr. Stirling, in 1816, which was successively improved by him and his brother up to 1840. Among the engines which have been more or less successful have been those of Ericsson, Wilcox, Roper, Shaw, and Rider in this country, and Lauberau and Belou in France. Hot-air engines are broadly divided into two classes by the manner in which they use the air. In one class it is drawn directly from the atmosphere, used, and then discharged. In the other the same body of air is used continuously, being alternately heated and cooled. The latter class has the advantage of being able to use the air at a greater pressure, but they need a refrigerating apparatus, which is unnecessary with the first. When the engine is used for pumping purposes this constitutes no disadvantage, as the water can be passed around the part of the cylinder desired to be kept cool, and even when it is used as a motor, a water circulation can very readily be kept up by means of a supply tank of sufficient capacity. As the efficiency of any heat-engine depends upon the extremes of temperature between which it is worked, either the air used in the air-engine should leave the power-cylinder at the temperature of the atmosphere, or it must be made to give up a portion of its heat to some apparatus that will yield it again to the entering air. The first is impracticable, and attention has there-

fore been given to the construction of such an apparatus, termed a regenerator. This has taken various forms in different machines—from a number of simple perforated plates to nests of tubes. Practically it has been found most economical to attempt to abstract only a part of the heat, as to do more offers too great an obstruction to the passage of the air, with the result of losing as much in power as is gained in heat.

One of the earliest hot-air engines to obtain a recognized place as a valuable aid to motive power was the well-known engine of Ericsson, which has long been on the market, and has come into somewhat general use. It is of the class using a fresh charge of air with each stroke, the air being drawn into the cylinder, compressed, heated, and, after doing its work, discharged. The engine is made both for pumping and power, and is constructed in sizes up to four-horse. It is too well known to require any description here.

FIG. 9.



Quite recently a new and much simpler engine designed for pumping purposes has been perfected by Mr. Ericsson, and is now being manufactured. It belongs to the class in which the same air is used over and over again, being alternately heated and cooled. The cylinder is placed upright, and projects below a table, by which it is supported, into the fire-box placed beneath. This is an iron shell provided with the ordinary grate and brick-lining at its lower end when the fuel used is coal, and with three Bunsen burners when it is gas. The latter fuel is much the most desirable, as it is cleanly, no trouble, and allows of starting and stopping quickly, and of always having the heat under perfect control. The working parts of the engine are a pis-

ton fitting the cylinder tightly, a plunger moving in it loosely, and the system of cranks and connecting-rods by which the motion of these parts is communicated. The upper portion of the cylinder, through which the tightly fitting piston alone moves, is water-jacketed, and consequently remains cool, while the part below this becomes more or less highly heated. In this heated portion the plunger moves, alternately displacing the air from above the fire. It is a long iron shell filled with wool or other non-conductor, and provided with studs on its sides which keep it from the walls of the cylinder. The machine is started by giving a few turns to the fly-wheel, when it begins running of itself, the action being as follows:

The plunger being raised, the air below it is heated and expands, forcing the piston upward. As it does this, the plunger is brought down with a quick motion, displacing the air, which passes through the annular space between the plunger and cylinder wall to the upper part of the cylinder. Here it comes in contact with the cool surface of the water-jacketed portion and contracts, forming a partial vacuum below the piston, which then descends by atmospheric pressure. By the upward movement of the plunger, the air is again brought in contact with the heated bottom and sides of the cylinder, and the same operation is repeated. The plunger-rod passes up through the piston, and by means of the simple system of connecting-rods and cranks shown in the figure the proper motion is given the plunger. The pump is placed at the side of the cylinder, and its rod connected directly to the beam of the engine. The water is drawn into the pump and discharged through the water-jacket, the slight heating of the water in its passage through the jacket being no disadvantage, while the continual passage of fresh water readily keeps the cylinder cool. The engines have so far only been made for pumping purposes, but they can readily be adapted to those of a small power, by using only a part of the power of the engine in pumping. Four sizes of the motor are made, three with single cylinders, six, eight, and twelve inches in diameter, and one with two cylinders of the latter size. The first lifts two hundred gallons of water fifty feet per hour, with an expenditure of fifteen feet of gas, the second three hundred and fifty, the third eight, and the fourth sixteen hundred gallons, the same height, with a proportional consumption of fuel. The prices vary from two hundred and ten dollars for the smaller to five hundred and fifty dollars for the largest size. Only the two smaller sizes are at present made to burn gas. They are perfectly safe, so simple that they can be used by the most inexperienced persons, and for their special purpose are probably as cheap and satisfactory machines as can be made.

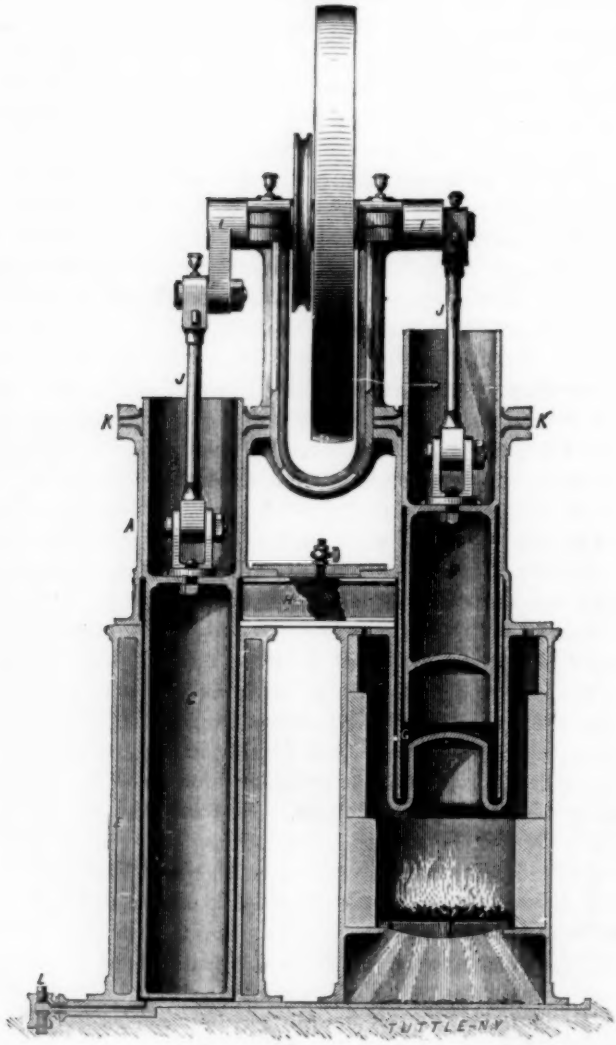
Another engine, and one of the most serviceable of this class of machines to be found in the market, is the Rider compression engine. Like the other hot-air engines, it is constructed chiefly with a view to pumping, but when desired for power in addition it may be ob-

tained fitted with a governor and the necessary pulleys at a slight increase of cost. The pumping-engines have found their way into very general use on railroads, country seats, and in city buildings, and from their economy in the use of fuel and their little trouble they have in all these situations proved very satisfactory. They are made only with coal-burning furnaces, and are on this account more troublesome than they would be if using gas, but are still but little more so than an ordinary coal-stove. Replenishing of fires and oiling are the only duties to be performed, and these can be done by unskilled labor. The engine occupies about the same floor-space as a moderately large coal-stove, and is about the same height. Two sizes are made, one of six, and one of ten-inch cylinder. The former will pump five thousand gallons of water to a height of ten feet in an hour, or a smaller amount to a proportionally greater height, at an expenditure of four pounds of coal, and the latter will raise twelve thousand gallons to the same height, in the same time, with eight pounds of coal. These amounts of coal are those used when the engine is run consecutively for ten hours. If run for a shorter time, the coal consumed per hour will be somewhat greater, owing to the starting of the fire. The engines weigh considerable, the smaller size being some sixteen hundred pounds, and the larger about double. The prices do not differ materially from those of steam-engines of from one to three horse-power.

The internal construction of the engine and manner of working are shown in the sectional view in Fig. 10. It is also of the type which repeatedly uses a given body of air, but, unlike the motor of Ericsson, the alternate heating and cooling are done in separate cylinders. The air is heated in the cylinder B and cooled in the cylinder A. The plunger C fits the cylinder A in its upper portion, but is contracted in the lower part to allow of an annular space between it and the wall of the cylinder. The power-piston D also fits its cylinder B tightly in the upper portion, but loosely in the lower heated part. A leather packing, K K, in each cylinder secures as in other engines a perfect fit of these moving parts. Between the two cylinders is placed a regenerator, H, consisting of a number of perforated plates, through which the air passes in going from one cylinder to the other. Around the lower portion of the cylinder B is a water-jacket, E, and encircling the same part of the heating cylinder B is a metal shell, F, curved inward at the base. The extension G of the cylinder B down into this shell forms a narrow annular space, through which the air entering the heater has to pass in a thin sheet, and thus becomes thoroughly heated. In action, the plunger C descends and compresses the air below it to one third its previous bulk; then by the further upward movement of the power-piston D and the completion of the down-stroke of the plunger, this air is transferred to the heater. This compressed air becoming heated expands and forces the power-piston to the end of its stroke, and entering the cylinder A carries the plunger

nearly to its extreme upper position. The air in contact with the water-jacket becoming cooled contracts, and the pressure is reduced below the power-piston, which then descends by the force of the atmosphere. As it reaches the end of its downward stroke and begins

FIG. 10.



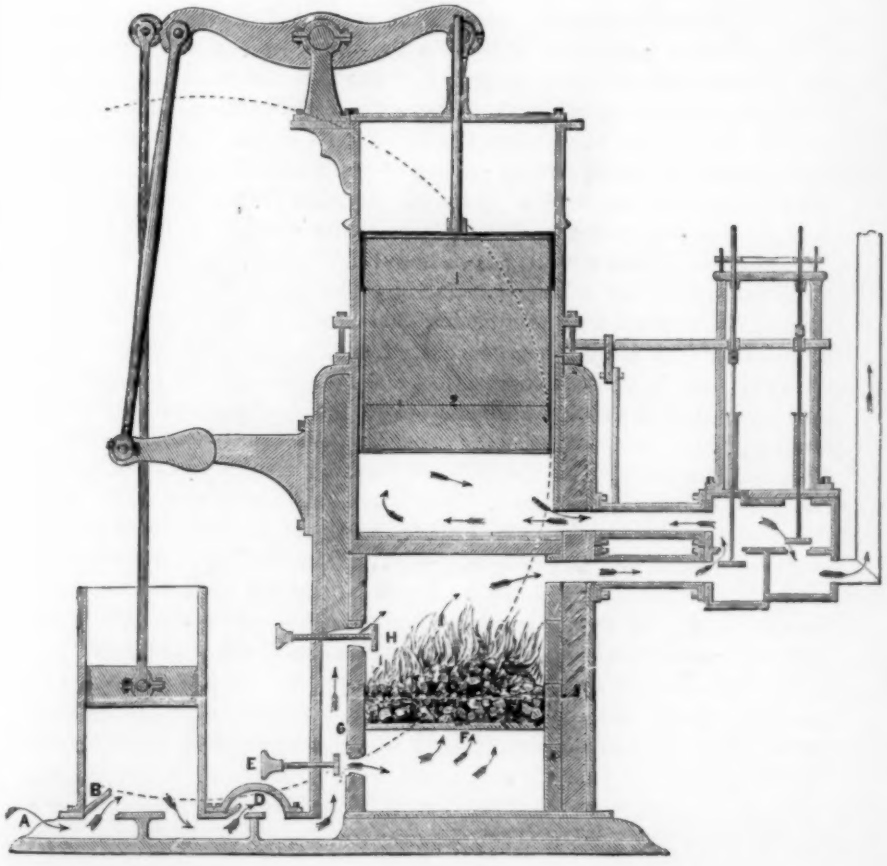

to ascend, the plunger comes down and the operation is repeated. When the air passes from the heater to the cool cylinder A, it heats the plates of the regenerator and this heat is given off to the cool air, when it is again forced into the heater. The utmost of the heat is thus utilized that is possible. The start in this as in all hot-air and gas

engines must be made by hand, but after a few turns of the fly-wheel the motion acquired is maintained by the engine.

The engine is supplied with either a deep well-pump, or one for use when the water is not more than twenty or twenty-five feet below it. The former is a simple contrivance, tubular in form, so that it can readily be inserted in artesian wells. The pump for use with water at less depths is of special construction, provided with rolling valves. It is bolted to the cooling cylinder, and worked directly from the compression piston or plunger. With one or the other of these pumps the motors can be adapted to every variety of circumstance in which water is to be drawn from one point and conveyed to another. Houses in the country can have as complete a water-supply, and have it in as convenient a shape, as those in the city, and at but little greater cost.

One of the best of this class of motors made for power purposes is the Sherrill-Roper engine, shown in section in Fig. 11. The manner

FIG. 11.



of using the heated air in moving the piston differs somewhat from that employed in the engines above described, being more nearly like that in which steam is used in the steam-engine. The furnace is air-tight, the air drawn from the atmosphere being forced through and over the fire, and the expanded air and products of combustion being admitted to the cylinder through valves worked by the engine in a way entirely similar to the admission of steam in the steam-engine. The cylinder is placed over the furnace, from which it is separated by a partition of iron faced with fire-brick upon the furnace-side. This furnace is lined with fire-brick upon all sides except the bottom, making a very durable construction, as there is nothing exposed to the direct action of the fire, to burn out. The air is drawn from the atmosphere by the upward movement of the piston in the small cylinder at the left, through the valve B, and on the down-stroke of this piston is forced through the channel G into the furnace. The valves H and E regulate the amount passed over and through the fire. The heated air and products of combustion are admitted into and exhausted from the cylinder through the puppet-valves, shown in the chamber to the right of the engine. A steady gradually diminishing pressure is exerted against the piston by these heated gases, and drive it to the upper end of the cylinder. The exhaust-valve then being opened by the mechanism of the engine, the piston descends by atmospheric pressure, forcing the gases out into the air. While the power-piston is making its downward stroke the supply-piston draws in a fresh charge of air, which is forced into the furnace during the up-stroke. A fly-wheel makes the motion of the engine smooth and uniform. The power-piston consists of two shells, the upper one turned true to fit the bored portion of the cylinder, and the lower one fitting it loosely. This latter protects the first portion from direct contact with the heated gases, and, as the upper part of the cylinder does not become overheated, a water-jacket is not needed. As the furnace is a closed compartment, the engine must be stopped in order to replenish the fire. This is not so much of an inconvenience, however, as it would at first sight appear, as one firing in the morning and another at noon, when the motor is running continuously ten hours a day, are all that are required. The machine is compactly built, and runs with very little noise. It is made in sizes of from one and a half to seven horse-power, at prices ranging from something less than five hundred to one thousand dollars. According to the statement of the manufacturers, the engine is exceedingly economical of fuel, the one-and-a-half horse-power using but forty pounds of coal per day of ten hours, and the three-and-a-half, eighty pounds. This is but a little over two pounds per horse-power per hour, a result attained in the steam-engine only in the larger-sized and most perfectly constructed machines.

# THE ADVANTAGES OF IGNORANCE.

By Professor F. W. CLARKE.

THE occasional blissfulness of ignorance has long been the subject of one of our most popular proverbs. Coupled with a positive statement as to the folly of wisdom, it passes from mouth to mouth with the authority of an oracle. But the support given to the dogma is usually of a passive kind. The doctrine is stated, but not defended; while on the other hand our journals teem with arguments in favor of education, upon the importance of schools, and about the best methods of electing school trustees. The fact that the latter represent in their own persons the advantages of ignorance—that educated men can rarely attain to such superior positions—is never urged with anything like proper vigor. Education in one's self imbues one with prejudices concerning the education of others; and such prejudices, with their attendant partialities, ought to be rigidly excluded from the management of public institutions. Accordingly, in actual practice, uneducated men are placed as supervisors above thousands of cultivated teachers; and thus, in spite of the schools, the superiority of ignorance is clearly demonstrated.

In every walk of life, in all professions, a similar superiority is daily manifest. At the polls, the trained and intelligent statesman is defeated by the loud-mouthed stump-speaker, who knows nothing of jurisprudence, less of political economy, and only enough of finance to be able to draw and spend his salary with commendable regularity. The broadly educated, highly cultivated theologian is surpassed in popular esteem by the swaggering revivalist, who tears up human feelings by the roots as a child pulls up sprouting beans for growing the wrong way. In medicine, the quack has five times the patronage of the well-informed physician, and makes a fat living where the latter would only starve. Sick people are fond of liberal treatment, and like to be thought worse off than they really are. You have a slight cold, and a good doctor charges five dollars for curing you. But the brilliant empiric calls it congestion of the lungs, diphtheria, or pneumonia, visits you twice as often, and charges three times as much, and you feel that you have got a great deal more for your money. Your own ignorance chimes in with his, and both are better satisfied. Your stomach-ache is magnified into gastric fever; your boil becomes an incipient cancer; a slight chill indicates approaching typhoid. The quack flatters your self-love, exalts your own importance in exaggerating that of your disease, comforts you with a good, sympathetic scare, and depletes your veins and your pockets with admirable equanimity.

The old saying that "fools rush in where angels fear to tread"

affords another argument in behalf of the fools. To be sure, the natural history of the angel species has been but imperfectly studied; yet here again our very ignorance helps us. Theoretically, we should all like to be angels; but, practically, we prefer to stay where we are. Besides, familiarity with angels might be exceedingly uncomfortable; especially if they should take it into the ghosts of their late heads to visit us in spook-fashion, with the accompaniments of blue-fire and winding-sheets. But to the point again. Education makes men cautious and calculating; careful of precedents; afraid of mistakes. Many a time the brilliant audacity of a daring ignoramus has achieved successes which would have been unattainable to orderly skill and training. Lord Timothy Dexter, that most inspired of idiots, sent a cargo of warming-pans to the West Indies. The natives took the bottoms for sugar-scoops and the perforated lids for strainers, and Dexter gained a fortune out of his ridiculous venture. Zachary Taylor, whipped by a Mexican army, was too bad a soldier to be conscious of his defeat, and kept on fighting. His adversaries, astonished at his perseverance, thought he must have hidden reserves, and incontinently ran away. Thus Taylor won the battle, as contemporaries say, "by sheer pluck and awkwardness." "Against stupidity the gods themselves fight powerless." Stupidity, therefore, by all the rules of logic, must be superior to sense, and truly deserves, over all competitors, the crown of laurel.

The advantages of ignorance may be further illustrated by a reference to the disadvantages of omniscience. Suppose one of us could know everything, past, present, and future—how uncomfortable he would be! Looking backward into remote antiquity, he would behold his ancestral ape engaged in the undignified performance of catching fleas. Turning with disgust from the past, he would find in the present many things as humiliating. Misunderstandings, bickerings, hatreds, and slanders, unknown to ordinary men, would stand revealed before him. And from the coming time he would anticipate trouble and misfortune; he would see approaching evils far off in the dim distance; and not even the knowledge of attendant pleasures could quite unsadden him. To know everything would be to learn nothing—to have no hopes and no desires, since both would become equally futile. After the first excitement, one would harden into a mere automaton—an omniscient machine—with consciousness worthless, and volition a farce. Had Shakespeare been able to foresee his commentators, his greatest works would never have been written.

There are two sides to every question. Like the god Janus, all things are double-faced. Knowledge is not unalloyed good; neither is ignorance unadulterated evil. If ignorance were abolished, how many teachers would starve for want of occupation! Were all fools to become sensible, what would the knaves do for a living? The ignoramus, so long as he is ignorant of his ignorance, is comfortable and

self-satisfied. The educated man sees how slender his attainments really are, and discontentedly strives for deeper knowledge. Let us be impartial, whether we praise, blame, or satirize. Blessed be stupidity, for it shall not be conscious of its own deficiencies.

## ÆSTHETIC EVOLUTION IN MAN.

By Professor GRANT ALLEN.

ALL the higher processes of evolution are necessarily so complex in character that we can really deal with only a single aspect at a time. Hence, in spite of the rather general title which this paper bears, it proposes to treat of æsthetic evolution in man under one such aspect only—that of its gradual decentralization, its increase in disinterestedness from the simple and narrow feelings of the savage or the child to the full and expansive æsthetic catholicity of the cultivated adult. We have to trace the progress of the sense of beauty from its first starting-point in the primitive sensibilities of the race or the individual to its highest development in the most refined and advanced of European artists.

To do so, we must first find this starting-point itself. What is the center from which the widening circle of æsthetic sensibility takes its departure? In other words, what is the primitive source of the appreciation of beauty? Putting the question into a concrete form, what objects did man, as a whole, and does each man in particular, first find beautiful? If we look at a cultivated European, we see that he derives great æsthetic enjoyment from contemplating the sunset clouds, the green trees, the lakes, rivers, and waterfalls, the flowers, birds, and insects around him. But, if we look at a savage or a child, we see that for the most part they care for none of these things. We might almost conclude, on a hurried glance, that they had no sense of beauty whatsoever. Yet, when we examine them a little more closely, we find that there are many objects to which they do apply some such word as *pretty*, the symbol of the simplest æsthetic appreciation. If we can discover the limitations of these earliest æsthetic objects, we shall have solved one of the most important fundamental problems in the theory of beauty.

The settlement of such fundamental problems seems to me an indispensable preliminary to the construction of a scientific doctrine of æsthetics. When professors of fine art discuss the principles of beauty, they are too fond of confining themselves to the very highest feelings of the most cultivated classes in the most civilized nations. The mere childish love of colors, the mere savage taste for bone necklets and carved calabashes, seem beneath their exalted notice. Nay, more, we constantly find them accusing one another of having no feeling for beauty,

or at least very little. Thus we see Mr. Ruskin and Mr. Poynter each mutually denying the other's powers of appreciation. But the psychological æsthetician can not confine his attention to such exceptional and highest developments of the love for beauty as engage the whole interest of these artistic critics. He must look rather to those simpler and more universal feelings which are common to all the race, and which form the groundwork for every higher mode of æsthetic sensibility. It is enough for him that all village children call a daisy or a primrose pretty: he need not go far afield to discuss the peculiar specific merits of a Botticelli or a Pinturiccio. Hundreds of thousands, who would stare in blank unconcern at a torso from the chisel of Phidias, can love and admire "the meanest flower that blows," with something not wholly unlike the welling emotions of a Wordsworth. Indeed, one is often inclined to fancy that the truest lovers of beauty in nature, or in the works of man, are not always those who can talk most glibly the technical dialect of art-criticism.

If we wish to hit upon the primitive germ of æsthetic sensibility in man, we can not begin better than by looking at its foreshadowing in the lower animals. There are two modes of æsthetic feeling which seem to exist among vertebrates and insects at least: the first is the sense of *visual beauty* in form, color, or brilliancy; the second is the sense of *auditory beauty* in musical or rhythmical sound. The former of the two modes I have endeavored in part to illustrate in my little work "The Color-Sense": the latter has been admirably treated by Mr. Sully in his valuable essay on "Animal Music," which appeared in the "Cornhill Magazine" for November, 1879. Now, if we look at the manner in which insects, birds, and mammals apparently manifest these presumed æsthetic feelings, we shall see that they are very restricted and limited in range. Animals never seem to admire scenery, or foliage, or beautiful creatures of other species. They do not appear for the most part to care greatly for human music, or for any sounds other than those uttered by their own kind. They do not even show any marked æsthetic enjoyment of the lovely flowers and fruits whose tints, as Mr. Darwin teaches us, are mainly due to their own selective action. But, if our great biologist is correct in his reasonings,* they

* I should like to add parenthetically that, since the appearance of my work "The Color-Sense" and the numerous criticisms to which it gave rise, I have fully reconsidered the whole question of sexual selection in the light of all that has been written about it, and feel only the more convinced of the general truth of Mr. Darwin's views upon the subject. It may be naturally objected that I am not an impartial witness in this matter: but I should like further to state that, on examining the various authorities, *pro* and *con*, I find in every case that the persons who are uncommitted to any special theological, quasi-theological, or metaphysical theory of evolution agree in full with Mr. Darwin, while only those differ from him who are bound down, *en parti pris*, to some more or less supernatural view of evolution, like Mr. Wallace, Professor Mivart, and Mr. J. J. Murphy, and who are therefore averse to any naturalistic explanation of the sense of beauty. I hope hereafter and elsewhere to enter more fully into this important question.

*do* very distinctly display their admiration for the beautiful forms, colors, and songs of their own highly decorated or musical mates. The facts on which Mr. Darwin bases his theory of sexual selection thus become of the first importance for the æsthetic philosopher, because they are really the only solid evidence for the existence of a love for beauty in the infra-human world. Granting the truth of his views (on which I for one have no shadow of doubt now remaining), we have good proof of a taste for symmetry and curved form in the magnificent tail of the lyre-bird, in the wedding plumage of the whydah-bird, in the twisted horns of the kudu antelope; of a taste for color and luster in the gorgeous train of the peacock, in the metallic necklets of the humming-bird, in the exquisite wings of tropical butterflies, in the bronze and gilded armor of the rose-chafers; lastly, of a taste for musical sound in the stridulation of the cicada and the house-cricket, in the deep notes of the bell-bird and the howler monkey, in the outpoured song of the linnet, the sky-lark, and the nightingale.

This close restriction of the æsthetic feeling to those objects which most nearly concern the individual, and through him the species, is only what we should naturally expect among the lower animals. We could hardly fancy them interesting themselves in anything so remote from their own personal wants as the rainbow or the sunset, the blue hills and the belted sea. They and their ancestors before them could not have gained any advantage by turning aside their attention from the practical pursuit of food or mates, to the otiose contemplation of that which profiteth nothing. Our own disinterested love for things so distant from our substantial needs has arisen gradually through a long process of ever-widening sympathies and ever-multiplying associations. But two things the insect, the bird, or the mammal could notice, and gain an advantage for itself or its race by noticing. It could pick out by its eye the forms and colors of edible foodstuffs among the unedible and relatively useless mass of foliage upon earth—the red berry or blossom from the green leaves, the fat white grub from the brown soil, the lurking caterpillar from the stalk whose lines and hues it so exactly imitates. It could distinguish by its ear the chirp of the savory grasshopper from the click of the hard or bitter beetle, the pretty note of the harmless sparrow from the deep cry of the dangerous hawk or the greedy jay. Thus eye and ear alike became educated among the superior articulates and vertebrates, in anticipation, as it were, of their higher æsthetic functions.

In the choice of mates, however, the powers so gained were exercised in a way which we can not consider as falling short of the true æsthetic level. Even the lowest animals (among those in which the sexes are different) seem instinctively to distinguish their fellows from all other species. In the higher classes, where the eye and ear have been so educated as to discriminate minutely between various forms, colors, shades, and notes, the instinct must almost certainly operate

through the senses of sight and hearing. Even among those races of insects, birds, and mammals in which no distinct marks of sexual selection exist, I believe the sight of beautiful members of their own kind must necessarily excite pleasurable feelings worthy of being ranked in the æsthetic class. In other words, I believe every crow must think its own mate *beautiful*—not merely inferentially pleasant, but in the truest sense beautiful. There must be, it seems to me, such an intimate correspondence between the needs and the tastes of each species, that the sight and voice of a healthy, normal, well-formed mate must have become intrinsically pleasing for its own sake, as well as indirectly for its associations. The nervous centers of each species must, I conceive, be so constructed hereditarily as to answer congenitally to certain typical shapes and sounds often experienced ancestrally, and always with ultimate benefit to the race. Though the emotions require experience of the object to arouse them, when the object occurs the emotions naturally arise. Just as man has special cerebral structures—existing, though dormant, even in deaf-mutes—for the perception and production of human language, so, I can not but believe, every species of higher animal has special cerebral structures, with special corresponding blank forms of perception, for the intellectual recognition and appropriate emotional reception of its fellows and its mates. These feelings are innate in the sense that they occur spontaneously at sight of the proper objects. When Miranda falls in love at first sight with Ferdinand, the only young man she has ever seen, it seems to me that the poet has truly depicted a genuine psychological fact. At any rate, it is indubitable that, so far as man is concerned, the human voice has certain points of emotional and technical superiority over every other kind of musical instrument, and that the beauty of woman and of the human form is now and must always remain the central standard of beauty for all humanity.

The heart and core of such a fixed hereditary taste for each species must consist in the appreciation of the pure and healthy typical specific form. The ugly for every kind, in its own eyes, must always be (in the main) the deformed, the aberrant, the weakly, the unnatural, the impotent. The beautiful for every kind must similarly be (in the main) the healthy, the normal, the strong, the perfect, and the parentally sound.* Were it ever otherwise—did any race or kind ever habitually prefer the morbid to the sound, that race or kind must be on the high-road to extinction. The more every individual shares the healthiest tastes of its kind, and puts them in practice in the choice of a mate, the more is he or she insuring for descendants a healthy and a successful life whereby it hands on its own sound taste to future gen-

* This doctrine has been admirably illustrated by Mr. Herbert Spencer so far as regards the human species, in his essay on "Personal Beauty," which, though published long before the appearance of the "Descent of Man," really contains the germ of the doctrine of sexual selection.

erations. But, besides this fundamental typical beauty—the beauty which consists in full realization of the normal specific form—there is another source of personal beauty on which sexual selection may act, and through which it has produced the greater number of its most striking effects. This source may be found in the exercise of tastes otherwise acquired upon relatively unimportant details of form, color, or musical abilities. The taste for bright hues, acquired through the search for food in blossoms, berries, or brilliant insects, may be transferred to the search for mates, so that those mates will be most preferred which happen to vary most from the original typical coloration in the direction of more brilliant hues. The taste for musical sound, implied, as I have elsewhere tried to show on the lines laid down by Helmholtz, in the very structure of the auditory apparatus (at least in birds and mammals), may be exercised in the preference given among birds to the sweetest or the loudest singers. Unimportant ornamental points may thus be constantly developed by continual selection of small gradations, when they do not interfere with the general efficiency of the organism, till at length we get such highly evolved æsthetic products as the waving plumage of the bird-of-paradise, the sculptured antlers of the gazelle, and the varied song of the mocking-bird. And since, as Mr. Wallace has shown (he himself believes in opposition to, but I rather fancy in confirmation of, Mr. Darwin's theory), these ornamental adjuncts or faculties are most likely to coexist with the highest sexual efficiency, it must happen that in the main sexual selection and natural selection will reënforce one another, the strongest and best being always on an average the most beautiful, and hence the most pleasing to all possible mates.

In this way, I take it, a sense of beauty in the contemplation of their own mates must have grown up among all the higher animals, and must have became strongest and most discriminative among those whose mates have undergone the greatest amount of ornamental differentiation. And as the secondary differences between man and woman as to beard, hair, and features, are greater than between the two sexes of almost any other quadrumanous animal, we may conclude that man's æsthetic appreciation of beauty in his own species has always been very considerable. Of this æsthetic appreciation, the secondary differences in question are at once the proof, the cause, and the effect. For, in the constant action and reaction of heredity and adaptation, it must happen that the greater the original taste, the more will it be exerted in the choice of mates; and, the more it is exerted in each generation, the greater will be its effects, and the more will the taste be strengthened in all future generations.

This, then, would seem to be the primitive starting-point of which we are in search. Man in his earliest human condition, as he first evolved from the undifferentiated anthropoidal stage, must have possessed certain vague elements of æsthetic feeling: but they can have

been exerted or risen into conscious prominence only, it would seem, in the relation of primeval courtship and wedlock. He must have been already endowed with a sense of beauty in form and symmetry, a sense which, in spite of its wide expansion and generalization in subsequent ages, still attaches itself above every other object, even with Hellenic or modern sculptors, to the human face and figure. He must also have been sensible to the beauty of color and luster, rendered faintly conscious in the case of flowers, fruits, and feathers, but probably attaining its fullest measure only in the eyes, hair, teeth, lips, and glossy black complexion of his early mates. And he must have been moved, as Mr. Darwin argues, by musical tones and combinations, though chiefly in the form of human song or rhythm alone. In short, the primitive human conception of beauty must, I believe, have been purely *anthropinistic*—must have gathered mainly around the personality of man or woman ; and all its subsequent history must be that of an *apanthropinization* (I apologize for the ugly but convenient word), a gradual regression or concentric widening of æsthetic feeling around this fixed point which remains to the very last its natural center. By the common consent of poets, painters, sculptors, and the world at large, the standard of beauty for mankind is still to be found in the features and figure of a lovely woman.

Probably primitive man admired his pre-glacial Phyllis or Neæra, admired himself, and perhaps also admired his fellow-man. So far as I can learn, there are no savages so low that they do not discriminate between pretty squaws or gins and plain ones, between handsome men and ugly ones. Our own children appear to me to make the distinction among their playmates from a very early age. And, in both cases, I am satisfied that their judgment in the main agrees with our own.* But it does not seem likely that primitive man took much notice of scenery, of organic beauty as a whole, or even very largely of beauty in flowers, berries, butterflies, and shells. Yet there was an obvious link, a simple stepping-stone, by which nascent æsthetic feeling might easily pass from the one stage to the other. That link is given us in the love for personal decoration.

Not only does every unsophisticated man wish to find a pretty mate, but he also wishes to look to advantage in her eyes and those of his rivals. Similarly, every woman wishes to look pleasing toward all men. The most naked savages take immense pains with their fantastic coiffures. Even birds display their beauty to the best advantage, and sing in emulation with one another till their strength fails them. But birds and mammals generally go no further than this : man can take one step in advance, and add to his natural beauty, or conceal his

* I noticed in Jamaica that the negroes generally considered as pretty negresses the same women as we should ourselves have selected among them ; and many persons who have traveled among various savage races, and whom I have had an opportunity of questioning, confirm this general conclusion.

natural defects, by borrowed plumes. So the earliest evidence of derivative æsthetic feeling which we possess is that of the personal ornaments worn by palæolithic men. Perforated shells, apparently used for necklaces; teeth of deer and other animals; pebbles of rose-quartz and other ornamental stones; wrought pieces of bone or mammoth-ivory—all of them obviously intended for personal decoration—are found in the earliest cave-dwellings and rock-shelters. Feathers and flowers we can not of course expect to find in such situations; but we can hardly doubt, from the analogy of almost all modern savages, that palæolithic men must have used them as much as they used those other decorative objects. Now, the fact that any such shells or plumes are sought as ornaments proves of course that they were first admired; but the vague admiration originally bestowed upon them would naturally be much quickened and increased by their employment for the decoration of the person. From being vague and indefinite it would become vivid and purposive. Our own children and modern savages take comparatively little interest in flowers in the abstract, flowers as they grow upon the bush or in the field: but they begin to admire them when they pick them by handfuls, and still more when they are woven into a wreath, arranged in a bouquet, or stuck into the hair. Nay, is not this ultimate decorative intent one of the chief *raisons d'être* for many of our European conservatories and florists' shops? Is not a camellia largely admired because it looks so well in a ball-dress, and a stephanotis because it fits so easily in a button-hole? And is it not a fact that many of our ladies and most of our servants admire artificial flowers, with all their stiffness and vulgarity, far more genuinely than they admire living roses or lilies-of-the-valley? We have all known women whose most real æsthetic feelings were obviously aroused by a bonnet or a head-dress.

Flowers are very favorite decorations with the South-Sea Islanders, and those who have read Miss Bird's and Mrs. Brassey's pleasant accounts of their stay among the Polynesians must have noticed the air of refinement, the vague æsthetic atmosphere thrown over the whole story by their profuse employment of tropical blossoms upon all occasions. Feathers, symmetrically arranged, were the ordinary head-dress of the North American Indians; and they were woven into splendid cloaks by the Hawaiians. Corals, pebbles, precious stones, gold and silver jewelry, cowries, wampum beads, furs, silks, and so forth, follow in due order. Ochre and woad, for dyeing or staining the body, are employed from a very early period. Henna, indigo, and other cosmetics come a little later. Among many existing lowest races, the only sign of æsthetic feeling, beyond the sense of personal beauty and the very rudest songs or dances, is shown in the employment of dyes or ornaments for the person. Such are many of the Indian Hill tribes, the Andamanese, the Digger Indians of California, and the Botocudos of Brazil. The Bushmen, and to a less extent the Australians, gen-

erally ranked in the lowest order, reach a decidedly higher æsthetic level.

In most savage communities, the men, not the women, monopolize the handsomest costumes, which are worn as marks of distinction, not merely as ornaments. But the former use must be necessarily derivative and secondary, not original. Mr. Herbert Spencer has gathered together a large and interesting collection of cases in his "Ceremonial Institutions" (chapter ix). Nevertheless, the original æsthetic intent of most of such decorations is obvious from the fact that they are universal among women, whenever they do not arise from the habit of trophy-taking, as with the use of flowers with the Polynesians generally. So, too, tattooing and other mutilative practices, originally subordinative in their intention, becoming at last merely æsthetic, are prized by women as increasing their natural attractions. Every one must remember the plea of the New Zealand girls, quoted by Mr. Darwin, who answered the remonstrances of the missionary against tattooing by saying, "We must have just a few lines upon our lips, or else when we grow old we shall be so very ugly." Similarly, Central African women admire their own *pelelé*, the piece of wood inserted in their mutilated lips. I notice in many works of travel that, even where the men almost or entirely monopolize the ornaments, the women are always described as displaying great admiration for the beads, red cloth, and other finery taken about by travelers. I may add that I am often struck by the extraordinary folly of missionaries, who habitually preach down the love of ornament on the part of savages or of emancipated slaves (especially the women), when in reality this love is the first step in æsthetic progress, and the one possible civilizing element in their otherwise purely animal lives.* It ought rather to be used as a lever, by first making them take a pride in their dress, and then passing on the feeling so acquired to their children, their huts, their gardens, and their other belongings.

Such in fact has been, I believe, the actual course of our æsthetic evolution. The feelings vaguely aroused by beautiful objects in the non-practical environment become whetted and strengthened by exercise upon ornaments and pigments, and so extend themselves with increased vividness into new channels. Art, however rude, has especially helped on this primitive progress. The appreciation for the beautiful in man's handicraft leads on to the appreciation of the corresponding beauty in natural objects. I have attempted to trace this reaction, so far as regards the sense of symmetry, in a previous number of this journal,† and I shall endeavor still further in the

* I once asked a West Indian official of great experience and liberal views whether, in his opinion, Christianity had done any practical good to the negroes; and I was much struck by his answering: "Oh, yes! It makes them dress up in good clothes once a week, and so gives them an object in life for which to work and save."

† See an article on "The Origin of the Sense of Symmetry," in "Mind," xv.

present paper to illustrate its progress in a somewhat different direction.

From delight in the beauty of ornaments to delight in the beauty of weapons or other utensils is but a step. What a man carries in his hands is almost as much a matter for personal pride as what he wears around his neck or his waist. From the very earliest ages, the material for palæolithic stone hatchets seems to have been intentionally chosen with conscious reference to beauty of color. Among the minerals so employed were "red or other colored jasper"; "greenstone, mottled jade, and green jasper"; "quartz, agate, flint, obsidian, fibrolite, chloromelanite, aphanite, diorite, saussurite, and staurotide." The bone knife-handles and other utensils from the rock-shelters of the Dordogne (of palæolithic date) are admirably carved into the forms of animals, or decorated with ornamental patterns. Indeed, both in outline and detail, most works of art of the chipped-flint period show very distinct æsthetic care, which is often marvelous when one considers the extremely rude nature of the tools in use, and the immense extra labor entailed upon the maker by any attempt at unnecessary ornamentation. The weapons of all but the very lowest existing savages show similar marks of æsthetic care. Their stone hatchets, besides being exquisitely polished, like those of the European neolithic age, are fitted in smooth wooden handles, and bound to the shaft by pretty twisted strings of red and yellow fiber. The Australian boomerangs are beautifully worked in hard wood. The staves or clubs of the Admiralty Island chiefs are wrought with the most exquisite and laborious tracery, which puts to shame our careless European wood-carving. The canoe-paddles of other Polynesian and Melanesian tribes are models of graceful and effective ornamentation. Among many savages belonging to the second rank, I find few works of art except weapons or like personal utensils on which any high degree of pains has been expended. We may therefore fairly regard this as the second human stage of æsthetic development.

Hardly superior to this second level is the love for decoration on vessels and other domestic utensils. Yet these, as being just one degree less personal than weapons, may be regarded as occupying a slightly higher stage. Calabashes and cocoanuts are almost always carved or decorated. Pottery from the very first is more or less ornamental in form, and even among very undeveloped savages is often prettily molded with lines or string-courses. Many of Dr. Schweinfurth's Central African specimens are extremely graceful; while several of the exquisitely simple prehistoric forms unearthed by Dr. Schliemann at Troy and Mycenæ have been adopted as effective models for the modern artistic Vallauris ware. France itself can produce nothing more beautiful in its own kind.

Decoration of the home is one degree more disinterested than decoration of the person or personal implements. The palæolithic savages

who carved the knife-handles and etched the pictures of reindeer or mammoths, in southwestern France, still lived in caves and holes of the rock. But as soon as man began to dwell in a hut, that hut began to take the impress of his growing æsthetic tastes. Swiss lake-dwellings present regular square or circular ground-plans. Esquimau snow-houses are finished with as much regularity and neatness as if they were built in the most durable material. Almost all savage huts are picturesque in shape, and some are even artistic in their simple style of architecture. The rudest tribes care for little but the exterior of their dwellings, since the interior is only used as a shelter for sleeping or a retreat from wet weather, not as a place of reception. Pride in personal possessions, we must always remember, has uniformly formed the stepping-stone on which our nature has slowly risen to a higher æsthetic level. So, we find houses beginning to be ornamented internally just in proportion as they are used for purposes of display. Even our own homes usually have the drawing- and dining-rooms much more elaborately decorated and furnished than the other parts of the house. The state-apartments of halls and palaces contain all the best pictures and the handsomest mosaic tables that their owners possess.

At this stage, the governmental and ecclesiastical impetus begins to be strongly felt. From the very beginning, indeed, æsthetic products are specially the attributes of royalty and divinity. The clubs and paddles noted above are those of chiefs alone: the Hawaiian feather mantles were *taboo* to the royal family: the ivory scepter and the vermilion-painted face "belonged alike to the Roman god and to the Roman king." But, when we reach a state of culture at which the royal palace and the temple are widely different from the huts of the subject, we find a great æsthetic advance. Architecture is indeed a specially regal and religious art. All early buildings of any pretensions are either palaces or shrines: only at a comparatively late stage of evolution, and under an industrial *régime*, do handsome mansions of commoners begin to exist. Even in our own day, if we see an exceptionally large and pretentious house, we take it for granted that it is, if not a palace, at least a public building. In India, all the great architectural works are either mosques and temples or palaces and mausoleums of native or foreign rulers. In Egypt, they are either pyramids of dead kings or fanes of still earlier gods. So, too, in Mexico, Peru, Central America. The catalogue of the works of art in Solomon's temple and Solomon's house, whether authentic or not (and good authorities accept it as historical), represents at any rate the æsthetic status of the Hebrews at the date at which it was committed to writing.

The king, then, from the first surrounds himself with such natural or artistic products as add to his impressiveness and dignity. Trophies and other decorations of warlike origin, badges and costumes, paint and ointment, have been so fully treated in this connection by Mr.

Herbert Spencer in his "Ceremonial Institutions" that I need not dwell upon them further here. But a few words as to later and more developed stages may not be out of place. Architecture is the central royal art, and its first object is to "beautify the house of the king." Beginning with the regal hut, it goes on to the frail and gilded palaces of China and Burmah, the house of cedar which King Solomon builded, the vast piles of brick erected by Assyrians and Babylonians in the alluvial valley of the Euphrates, the solid granite colonnades of Thebes and Memphis, the huge marble domes of Agra and Delhi, the stucco monstrosities of Mohammedan Lucknow. Sculpture first grows up as the handmaid of architecture, and begins its modern form with the basreliefs of Egypt and Assyria, or the rock-hewn colossi of Elephanta. We still see the conjunction between royalty and these two sister arts in the beautiful Renaissance façade of the Louvre and the tasteless gilding of the Albert Memorial. Beside the ancient Nile or in the courtyards of Nineveh, we find the subjects ever the same—the king conquering his enemies; the king hunting and slaying a lion; the king driving a herd of naked captives to his capital city. Thus the aggrandizement of royalty becomes at the same time the opportunity for the exercise and development of plastic skill, while it affords models of the beautiful in art for the admiration and the æsthetic education of the subject throng.

Similarly with painting. Beginning with the rude decoration of the savage cloak and girdle, it advances to the smearing and gilding of the royal hut. Thence it progresses to the brilliant coloration of Egyptian columns and frescoes, and to all the Memphian wealth of blue, green, crimson, and gold with which so many modern restorations have made us familiar. In India, debarred from imitation by Moslem restrictions, it produces the exquisite decoration of the Taj and the Delhi palaces: in western Islam, it gives us the gorgeous Moresque tracery of the Alhambra. In its regular European development, becoming mainly ecclesiastical during the early middle ages, it reasserts its original governmental connection in the palaces of Florence and Venice, in the Vatican, in the Louvre and the Luxembourg, in Whitehall and Hampton Court, in Dresden and Munich, in modern Berlin and St. Petersburg. Sèvres and Gobelins were originally royal factories: Giotto, Michael Angelo, Raphael, Holbein, Rubens, Vandyke, all produced their masterpieces for popes or kings—Leo X, Henri IV, Charles I. Conversely, American artists have often noted the chilling effect of the want of a court upon the æsthetic susceptibilities and creativeness of their countrymen generally. Europe has, on the whole, purchased its art at the hard price of its long apprenticeship to despotism. In India, native art has steadily died out with the gradual extinction of the native courts. In Hellas and Italy it happily survived royalty because pressed into the double service of religion and of the sovereign people in its corporate capacity. What the

house of Pharaoh was to Egypt, that was the house of Athene to Athens.

The gods, indeed, have done almost more for the expansion of the æsthetic faculty than even the kings. If the savage decorates the living chief and his house, how much more must he decorate and beautify the image and the house of that greater dead chief, the god —that ancestral ghost whom even the living chief dreads and venerates exceedingly! Hence, from the very first, while the ornaments of the king and the god are the same in kind, those of the god are the finest in degree. As the ghost gradually expands into the vaguer grandeur of the deity, his worship is surrounded with increasing magnificence. It is the temples of Heliopolis and Benares which naturally occur to our minds when we think of Egyptian or Indian architecture. It is the pyramids and mausoleums that form the initial stage of ecclesiastical buildings. All the world over, the shrines of the gods are the most splendid of all erections: only where faith is on the decline do we find the palace or the mansion outvying the cathedral and the chapel. In architecture, in sculpture, in painting, in music, the homes of the gods are the highest expression of national æsthetic feeling. Passing from the painted pillars of Karnak to the temples of Khorsabad and the mosques of Agra, we find the same care everywhere bestowed upon the service of the deities. In Hellas, we have the Parthenon and the Theseum; we have the chryselephantine statues of Phidias, and the votive tablets of Praxiteles. The marbles of Pentelicus or Paros permitted the Hellenic Aphrodite to assume a graceful and natural pose, which would have been impossible with the stiff granite limbs of a Pasht carved out from the quarries of Syene. At Rome, we have the Capitoline Jove, yielding place at last to the palace of the Divus Cæsar and to the basilica of the Christian apostle. All classical architecture, all classical sculpture, the larger part of classical painting, and no small part of classical poetry, are directly due to the influence of the old Helleno-Italian religions. And whatever little information we can gather of the æsthetic status of the Hebrews is to be derived from the story of the hangings and vessels of the tabernacle, and the molten sea, the pillars, the bases, the lavers, and the cedar ceiling of Solomon's temple. Hebrew poetry is almost without exception devotional.

In Christian times, the connection between art and religion has been even more noticeable. Our music is directly affiliated upon the Gregorian chant, and derives its notation from ecclesiastical usages. Masses and oratorios still compose its masterpieces. Our painting has come down to us from Byzantine and early Italian models, and found its home during the whole mediæval period in the great cathedrals and churches of Italy, whence it spread to the palaces of the Florentine Medici, of the Venetian doges, and of the Genoese merchant princes, and so ultimately to northwestern Europe. The whole character of

pictorial art up to the Renaissance was entirely ecclesiastical and devotional. We have fed and nursed our taste upon Madonnas and Holy Families, upon Crucifixions and Assumptions, upon St. Sebastians, St. Johns, and St. Cecilias. Our architecture is based upon the Romanesque Christian church, whose rounded forms melt into the pointed arches of the Gothic cathedral. It finds its noblest expression in Pisa and Poitiers, Milan and Venice, Cologne and Chartres, Lincoln and Salisbury. And, when the classical revival comes to restore the older schools, it produces the masterpiece of its newer style in the vast dome of St. Peter's, where the four chief arts, architecture and sculpture, painting and music, all alike find their chosen home in the central point and focus of Catholic Christendom.

Nor is it only in these more notable forms that royalty and religion influence æsthetic taste. The purple and fine linen of kings' palaces; the inlaid cabinets and parquetry floors; the jade vases and painted porcelain; the Dresden statuettes and bronze candelabra; the frescoed ceiling, tapestry wall-covers, and carved wood-work—all these belong to the royal home. Even in poetry, the Queen still keeps her laureate; and the drama, originally a sort of royal specialty, is still performed at Drury Lane by "her Majesty's servants." Similarly with religion: the stained-glass window and the marble or mosaic altar; the costly vestments and sweet-perfumed incense; the fretted roof and the sculptured reredos—these in their turn belong to the worship of God. Such royal decorations and sacred ornaments react again upon the popular taste, both actively and passively. As an active effect, they give rise to and foster artistic workmanship: as a passive effect, they educate and strengthen the æsthetic faculties of the mass. Among the lower races, the æsthetic feelings have been closely linked with the sense of proprietorship: among the higher races, they gain more and more with every step in abstractness and remoteness from the personality of the individual. It was in the vast cathedrals of mediæval Europe that modern æsthetic feeling received its early education.

So far we have treated little of beauty in nature: beauty in art has occupied almost our whole attention. The latter prepared the human mind for the appreciation of the former. Of the manner in which the love for art passes into the love for smaller natural objects, which exhibit minute beauty of workmanship, I have already treated elsewhere: but the taste for scenery demands a few words here. Children and early races care little for nature: it is only among the most cultivated classes of the most advanced types that the æsthetic faculty reaches this its highest and most disinterested stage. All art is at first frankly anthropinistic. Early painting, such as that of the Egyptians and Assyrians, dealt only with human and animal figures: it represented men and women, kings and queens, gods and goddesses, hunters and lions, herdsmen and cattle: but it never attempted landscape or scenery.

Mediæval art in its early stages only changed its characters to saints and angels, priests and bishops. But, as it progressed from its Byzantine type, it also gradually gave more and more importance to accessories in the background, in which hills, cities, rocks, and trees, began to play a conspicuous part. At last, after the Renaissance, landscape-painting became a recognized and separate branch of pictorial art, first with an admixture of figures, wild animals, or still life, but afterward in a more fully differentiated form, with all its varieties of marine, architectural, forestine, or river subjects, its waterfalls, its clouds, its rocks, its valleys, and its heather-clad hills. Even in our own day, very young people and the uncultivated classes care little for any but figure-painting: children pass over the landscapes in their picture-books, and fasten at once upon the man on horseback or the boy with a top. The first object they try to draw for themselves is a human face. So, too, with literature. All primeval literary works consist of a legend, a story historical or mythical, the tale of what some man or some god has done. To the very end, novels, plays, and biography, the most human in their interest, are the favorite forms of literature. Poetry at first is all epic or narrative: lyric and descriptive verse only come in at a much later point of evolution, and are seldom thoroughly relished by any but the most cultivated. "Tell me a story," says the youngest child. "History is the most delightful of studies," says the Roman philosopher.

We may take the Homeric poems as an excellent illustration of human æsthetic feeling in this its naïvely anthropinistic stage. In them we find human beauty abundantly recognized and admired: Helen, for whose sake Trojans and Achaians may well contend through ten long years; Paris, on whose eyes and hair Aphrodite pours the gift of loveliness; the golden locks of Achilles, the white arms of Here, the hazel eyes of Athene, the fair cheeks of Briseis. There is much admiration, too, for works of primitive art—the gōlden-studded scepter, the polished silver-tipped bow of horn, the jeweled girdle of Aphrodite, the wrought figures on Achilles's shield, the embroidered pattern on the many-colored peplum which Theanô offers on the knees of Athene. The palaces of Priam and of the Phæacians excite the warmest praise of the rhapsodist. But of scenery there is little said, as is also the case in the Hebrew poets. The garden of Alcinous is, after all, but a well-ordered fruit-orchard. Nature is only alluded to as a difficulty to be overcome by man—the barren, harvestless sea; the high, impassable mountains; the forests where roam the savage wild beasts. In the Periclean age, we have a higher but still not a very exalted standard as regards natural beauty; the "Bacchæ" of Euripides being the high-water mark of Athenian love for the picturesque, and standing out in this respect as a solitary example among its contemporaries. With the greater security of Roman rule, life became less confined to the immediate neighborhood of cities; moun-

tains and forests and waterfalls became more easy to visit; and in the "Georgics" we see the result of the change. Yet even in the "Georgics" the view of nature is still very anthropinistic, and the feeling for scenery decidedly urban. What should we say of a poet nowadays who should apostrophize the beauties of an Italian lake "Fluctibus et fremitu assurgens, Benace, marino"? Would he not seem in our eyes to have missed entirely the whole spirit of the scene? The words might do for Huron or Ontario, but fancy applying them to Como or Garda! Nevertheless, the Roman mind had decidedly advanced in the love of nature. The Alps were still to Juvenal mere masses of snow barring the way from Gaul to Italy; the ocean was still to Tacitus a boundless waste of western waters; but the falls of Tivoli, the little fountain-head of Bandusia, the sweeping coast-line of Baiæ, the beetling crags of Terracina, the deep volcanic basin of the Alban lake—all these could rouse æsthetic admiration and delight in the eyes of a Horace, a Virgil, or a Claudian. With the recession of the middle ages, when men were again confined to the narrow limits of towns, æsthetic feeling went back once more to the *naïve* anthropinism of an earlier age; but, since the Renaissance, the love of scenery has grown perpetually, and it now probably reaches the farthest development that it has ever yet attained.

But we must never forget that the taste for scenery on a large scale is confined to comparatively few races, and comparatively few persons among them. Thus, to the Chinese, according to Captain Gill, in spite of their high artistic skill, "the beauties of nature have no charm, and in the most lovely scenery the houses are so placed that no enjoyment can be derived from it." The Hindoos, "though devoted to art, care but little, if at all, for landscape or natural beauty." The Russians "run through Europe with their carriage-windows shut." Even the Americans in many cases seem to care little for wild or beautiful scenery: they are more attracted by smiling landscape gardening, and, as it seems to us, flat or dull cultivation. I have heard an American just arrived in Europe go into unfeigned ecstasies over the fields and hedges in the flattest part of the Midlands.

The reason for this slow development may be briefly traced. The minor component elements of scenery must always have been to a great extent beautiful on their own account even to children and savages. Thus, the same bright color which gave attractiveness to flowers and gems must also have given it, though more vaguely, to the rainbow and the sunset clouds, which could not similarly be utilized for purposes of ornament. Color must also always have formed an element of beauty in blue sky and sea, red-sandstone cliffs, white chalk, green meadows, and golden corn-fields. All these objects, however, being comparatively remote from personal interest, would be little regarded by the primitive mind. But, when cultivation began, the care of the husbandman and the æsthetic interest aroused by his regu-

lar neatness would naturally set up a new feeling. Straight rows of vines or olives, trim meadows, well-kept hedges, level fields of corn, excite the farmer's admiration. This is about the level ordinarily reached (though often surpassed) by the "Georgics." In the "Iliad," when a place is mentioned with any allusion to scenery, it is generally because it is "fertile," "horse-feeding," or "rich in corn"; with Virgil, it is the careful tillage of Italian peasants that provokes attention. But wild hills and rocks are mere barren, good-for-nothing wastes to the agricultural eye. A few days before writing this paper I was wandering among the beautiful wooded heights of the Maurettes near Hyères, when I came across a party of peasants taking their lunch on a little plateau outside their cottage. Wishing to apologize for my intrusion, I said a few words about the singularly lovely view which their house commanded across the mountains and the sea. "Ah, yes," said one of the peasants in his Provençal *patois*, "there isn't much to see this way except the forest; but down there," pointing behind him in the opposite direction, toward the great cabbage-garden which covers the alluvial plain of Hyères—"down there one sees a magnificent country." The one view was like a bit of miniature Switzerland; the other, like a huge market-garden, as flat as this page.

Even in our own time and place, among our own race, one may see a similar æsthetic level with farmers and laborers. "So you're going to Devonshire," said a Lincolnshire yeoman to his minister (from whom I have the story); "you'll find it a poor sort of country after this. You'll never see a field of corn like ours down there, I take it." "Your country, sir," says a distinguished American visitor in England, "is very beautiful. In many parts you may go for miles together, and never see a tree except in a hedge. Nothing more beautiful can be conceived." (I take the words down from the report of an "interviewer.") To the farmer, hills like those of Devonshire were mere obstructions to ploughing: in the eyes of the practical American, trees were simply objects to be stumped and annihilated in the interest of good farming.

So long as communications are difficult and roads bad, this agricultural aspect of natural beauty will remain uppermost. It is difficult to appreciate scenery in the midst of practical discomforts. The Alps were naturally mere barriers of snow to Hannibal and Cæsar. The Scotch Highlands were less beautiful to Lowlanders when they were inhabited by hostile clansmen with a taste for cattle-lifting. Even in the last century, one is struck by the many serious discomforts which Johnson suffered in going to the Hebrides or traveling through Wales. Telford's Holyhead road must have done much to quicken the æsthetic sensibilities of the eighteenth century in England. I have myself noted in Jamaica how much the appreciation of really beautiful scenery is spoiled by the discomforts of the climate and the difficulties of transport. In such circumstances, an æsthetic feeling for scenery can hardly

develop itself. Still less could it do so during the perpetual state of siege in the middle ages, or the constant warfare of the little Hellenic republics, when no man could travel a few miles from home save on urgent business and with due precautions. A lovely pass or a frowning gorge can hardly become beautiful in the eyes of those who see in it everywhere a lurking brigand.

On the other hand, when traveling becomes easier, a taste for scenery naturally arises. All the mental elements of the taste are already present ; only their combination is wanted to complete the æsthetic growth. Tastes educated and refined by the arts of the city must find beauty ready to hand in much of the country. The garden and park, the Italian terrace and the Versailles avenues, the ornamental grounds and artificial lakes of the last century, formal as they seem to us now, show the gradual growth of the taste. A view from the castle or the hall becomes a desideratum. To look out upon fresh green fields and trees rather than upon the walls and narrow streets of a city must always have been pleasant to all but the most restrictedly anthropinistic minds—though even in our own day there are many townsmen who would find more to interest them in a crowd of people than in the loveliest scenery on earth. Again, only highly cultivated minds can thoroughly enjoy the beauty of places which have been always familiar from childhood : and we can hardly expect a taste for scenery to develop among people who necessarily live (like all but the most civilized) in one narrow place for all their days. Under such circumstances, the perception of its beauty can never arise. The habit of making tours, at first confined to the very wealthy, but gradually spreading down to the middle classes and the mass, has undoubtedly had an immense effect in strengthening the love of nature. Those who only know the stereotyped features of their own suburban fields, often flat and unlovely, can not acquire any deep interest in scenery. But when Wales and Scotland, Auvergne and Brittany, Switzerland and the Tyrol are thrown open for us all, the habit of comparing, observing, and admiring grows upon us unawares. Those railways which Mr. Ruskin so cordially despises have probably done a thousand times more for promoting a love of beauty in nature than the most eloquent word-painting that was ever penned even by his own cunning and graceful hand.

If one may trust an individual experience, it is not the first waterfall that charms the most. Niagara itself, when seen in early youth, does not produce nearly so strong an impression as the little Swallow-Fall at Bettws-y-coed in later years. The more one sees, the more one learns what to expect, what to observe, what to admire. Here it is the wind-shaken foam-streak of the Staubbach ; there, the little dancing cascades of the Giesbach ; and here again, the vast unbroken emerald-green sheet of the Horseshoe Fall, pouring in ceaseless majesty into the seething turmoil of waters at its mist-begirt feet. Each

has its own beauties of grace, prettiness, or sublimity, and each is largely apprehended and appreciated by means of half-unconscious recollections of the others. Between the American and Canadian falls at Niagara, a little belt of water forces its way through the gap which severs Goat and Luna Islands, and forms a minor cataract of its own, hardly heeded in the presence of the two great rivers plunging headlong at its side. If one fixes one's attention for a few moments on this little sheet of foam, one recognizes after a while that it is really larger than any cascade in western Europe. And, if you then turn your eyes to the vast semicircle of deep-green water on your right, you feel at once that without that standard of measurement your eye and brain would have failed adequately to grasp the mighty dimensions of Niagara.

Thus, step by step, in our own individual minds, and in the history of our race, the æsthetic faculty has slowly widened with every widening of our interests and affections. Attaching itself at first merely to the human face and figure, it has gone on to embrace the works of man's primitive art, and then the higher products of his decorative and imitative skill. Next, seizing on the likeness between human handicraft and the works of nature, envisaged as the productions of an anthropomorphic creator, it has proceeded to the admiration for the lace-work tracery of a fern or a club-moss, the sculptured surface of an ammonite, the embossed and studded covering of a sea-urchin, the delicate fluting of a tiny shell. Lastly, it has spread itself over a wider field, with the vast expansion of human interests in the last two centuries, and has learned to love all the rocks, and hills, and seas, and clouds, of earth and heaven, for their own intrinsic loveliness. So it has progressed in unbroken order from the simple admiration of human beauty, for the sake of a deeply seated organic instinct, to the admiration of abstract beauty for its own sake alone.—*Mind.*

## A JAPANESE TYPHOON.

By Professor T. C. MENDENHALL.

CONSIDERABLE information has been gathered, and much has already been published, concerning the damage inflicted upon this coast and in the vicinity by the typhoon which visited us during the night of October 3d and 4th.

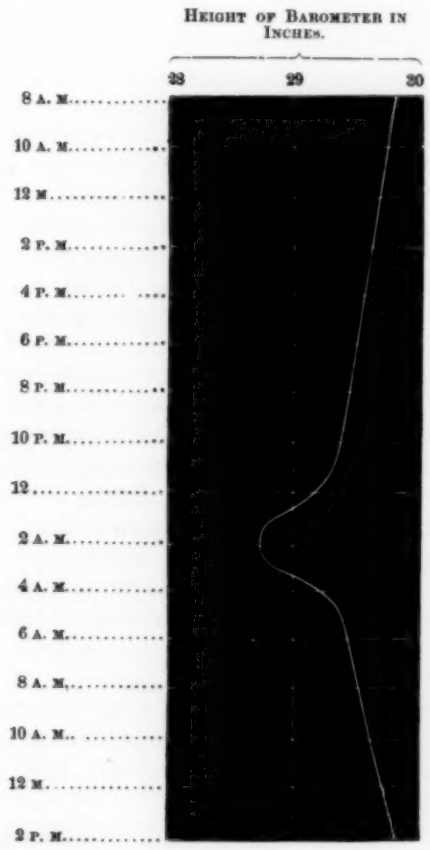
The unpleasant frequency, in this part of the world, of storms of the same character, renders their careful investigation by competent meteorologists a matter of the utmost importance. What is chiefly demanded, therefore, is the collection of such meteorological records and observations as may, perhaps, render it possible to trace completely

the rise, progress, and varying intensity of the storm. Of course, considerable time must elapse before such an investigation can be completed ; and, unfortunately, even at best the number of accessible and reliable series of observations will be greatly less than could be desired for the successful study of the phenomenon.

In the mean time we deem the matter of sufficient local interest to justify a brief presentation of the principal meteorological features of the storm, based upon observations and records made at the observatory of the University of Tokio.

Although it can hardly be said that this storm gave any marked indications of its immediate approach, yet it is important to observe that

CHART SHOWING THE HEIGHT OF THE BAROMETER FROM 8 A. M. ON THE 3D TO 2 P. M. ON THE 4TH OF OCTOBER, 1880.




there was a steady fall in the barometer from the previous Thursday—September 30th—up to the time of maximum violence of the wind. The first of the accompanying charts exhibits the barometric curve

during the most interesting period; i. e., from 8 A. M., on the 3d of October, to 2 P. M. of the 4th. Previous to one o'clock on the morning of the 4th but three observations are recorded: at 7 A. M., at 2 P. M., and at 10 P. M. These indicate a steady decline in the barometer, and it is not likely that any extraordinary fluctuations occurred during this time. After 1 A. M., the observations were made hourly, and during a considerable portion of the time they were half-hourly. It will be seen, however, that a very important portion of the curve, from 10 P. M. to 1 A. M., is doubtful, and it is not at all unlikely that, had intermediate observations been recorded, the fall of the barometer would have appeared much more sudden than it does. The minimum observed height was 28·735 inches at 2 A. M. At three o'clock the height was only a trifle greater than this, and, from the nature of the curve before and after the interval from two to three o'clock as well as from the velocity of the wind, it seems highly probable that between these hours a lower point than any observed was reached. The curve is constructed to show the actual vertical movement of the mercurial column. From the minimum it rose rapidly until 6 A. M., at which hour the height was 29·386 inches, and from that hour the rise continued with less rapidity but with great steadiness, until the night of the following Wednesday, when the reading was 30·378 inches. Thus the range of the barometer in three days was 1·643 inches. This is more than two tenths of an inch greater than the range for the whole of the last year. At no time during last year did the barometer reach so low a point as 29 inches, and the mean height for the year was 29·952 inches.

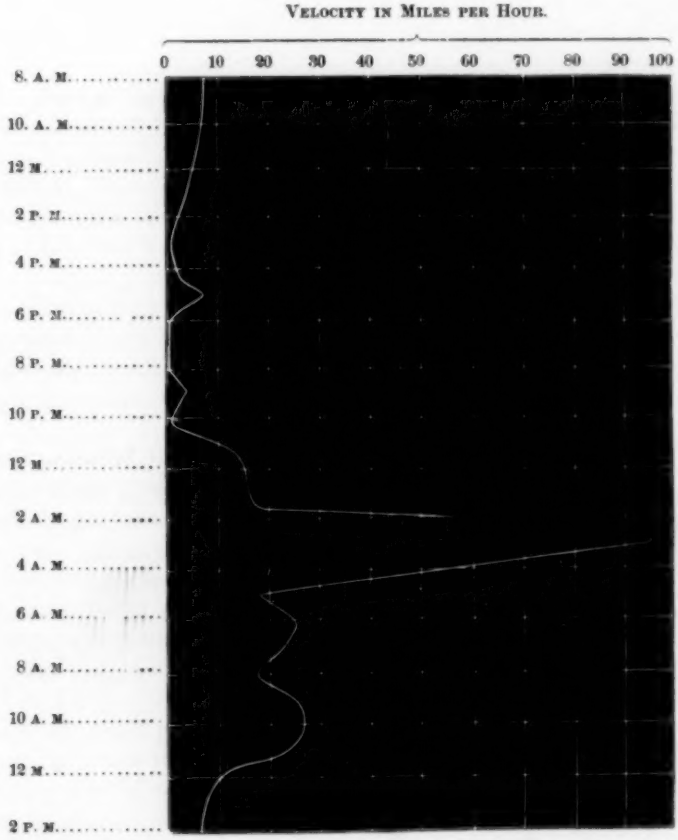
The second chart shows the velocity of the wind at different hours, extending over the same interval of time. These velocities are computed from a continuous record made by an anemograph consisting of a Robinson's anemometer with Beckley's registering apparatus attached. From this curve it will be seen that, so far as the wind is concerned, up to about 11 P. M., there were no indications of the coming storm. At that time a breeze sprang up, which continued at less than twenty miles per hour until about 1 A. M. when it suddenly increased in velocity, and at 2 A. M. the record shows a speed of sixty miles per hour. Unfortunately, shortly after two o'clock, the clock-work which keeps the registering portion of the apparatus in motion was stopped, the motion of the pendulum being undoubtedly arrested by a sudden blast of great violence. This stoppage was not discovered until 3 A. M., so that between these hours the record is lost. At three o'clock the instrument was put in motion again, and, for about fifteen or twenty minutes after that hour, the record shows the extraordinary velocity of ninety-five miles per hour. From this time the violence diminished rapidly, a velocity of fifty miles per hour being registered at 4 A. M., and at 5 A. M. it had fallen to less than twenty miles per hour. Twice afterward, as will be seen by the chart, the speed

rose to about twenty-five miles per hour, after which it rapidly declined.

Owing to the interruption in the continuity of these records, it is impossible to affirm that the maximum velocity of the wind was recorded. In fact, there are reasons for believing that the storm reached its greatest violence somewhat before three o'clock.

It seems quite certain, then, that at times during the storm the velocity of the wind exceeded one hundred miles per hour; and especially must this have been the case during some of the most violent blasts, which were generally of too short duration to show with their full effect upon the register made. The fact that the pendulum of the anemograph was stopped between two and three o'clock by one of these

CHART SHOWING THE VELOCITY OF THE WIND FROM 7 A. M. ON THE 3D TO 2 P. M. ON THE 4TH OF OCTOBER, 1880.




NOTE.—The break between 2 A. M and 3 A. M. in the curve representing the velocity of the wind is due to the fact that, between those hours, the registering apparatus connected with the anemograph was not in motion.

blasts, and that after three o'clock its motion was not interfered with, would indicate that more violent disturbances took place before than after that hour. A smaller anemometer of Robinson's model was torn from its fastenings between two and three o'clock, and so completely demolished that no record even of the work which it had already done could be obtained. This is much to be regretted, as otherwise a means of verifying the extraordinary velocity registered by the anemograph would have existed. Concerning the latter it should be said that, regarding the smaller anemometer as a standard, it has been found upon examination to somewhat over-estimate the velocity of very high winds, and to under-estimate those of low speed. At the same time it can not be positively stated which of the two instruments was in error.

A continuous record of the direction of the wind is kept. Upon examining this it is found that, during the whole of the period considered, the direction varied between north and west. Up to 1 A. M., of the 4th, the wind was steadily from the north-northwest. From that hour until 5 A. M., its fluctuations were confined between northwest and west. A decided change in direction seems to have taken place between the hours of two and three o'clock.

The early part of the storm was accompanied by an unusually heavy fall of rain. The violence of the wind prevented the reading of the rain-gauges during the night, but when emptied at 7 A. M. they showed a total of 4·66 inches, nearly all of which must have fallen during—at most—two or three hours.

It may be interesting to make some comparisons between the violence of this storm and that which was undoubtedly the immediate cause of the destruction of the Tay Bridge, on the evening of December 28, 1879. Unfortunately, it does not appear that any very exact or reliable observations of the velocity of the wind on that occasion were made; but an approximate measure of it may be obtained from the testimony of several of the witnesses, who were men of considerable experience in the observation and estimation of high winds. The following selections from the "Times" report of the Board of Trade inquiry are of interest in this connection. Captain Scott, R. N., who was superintendent of a training-ship stationed in the Tay, testifies that his barometer fell from 29·60 inches at noon to 29 inches at seven o'clock—that being the lowest point reached. Also, that, in the navy, storms were described by numbers from 1 to 12, 12 being the maximum. Upon that scale he would describe this storm in the Tay as from 10 to 11. He had on rare occasions in China and the West Indies rated storms as high as 12.

Admiral William Heriot Maitland Dougal, who had resided at the mouth of the Tay continuously for twenty-nine years, stated that his barometer fell from 29·40 inches to 28·80 inches. The difference between these and the previous barometric heights is easily explained by

the fact that his house was at an altitude of two hundred feet above the level of the sea. He declared that the gale was like a typhoon in violence, and that in all the time during which he had lived on the Tay he had never experienced a gale of equal severity. In his opinion the velocity of the wind was from seventy-five to seventy-eight miles per hour, and that during the lulls it would fall to something like thirty.

Charles Clark, who was an amateur observer, gave evidence that 29·00 inches was the minimum point reached; that he had marked the storm 4 on a scale of 6; and that he had never yet recorded 5 or 6.

Other witnesses testified in about the same way, all agreeing reasonably well as to barometric depression and probable velocity.

On comparing these statements with those already made concerning the recent typhoon here in Japan, it will be seen that both in barometric range and in wind-velocity the recent storm considerably exceeded that which was the occasion of the Tay Bridge disaster. The barometric change was not greater, but more sudden in the former than in the latter. Concerning the direct measurement of the pressure of the wind in pounds per square foot, it must be said that the instruments for doing this are, at present, to a great extent crude and unreliable. It is generally assumed that the pressure is proportional to the square of the velocity. Upon a scale adopted by the Smithsonian Institution and by the United States Signal Service, the velocity of twenty-five miles per hour corresponds to a pressure of three pounds per square foot. Assuming the correctness of this, and also of the law given above, the pressure per square foot in the Tay storm must have been nearly thirty pounds, and in the recent typhoon here it must have been nearly fifty pounds. It was shown, in the tests made upon the material of the Tay Bridge, that it might have been expected to give way under a wind-pressure considerably less than forty pounds. The French and many English engineers have adopted fifty-five pounds per square foot as a standard, and about the same number is used in America, but it seems doubtful if even that furnishes a sufficient "factor of safety."

In conclusion, the affirmation may be made, supported as it is by the constantly accumulating evidence of the damage done to buildings, shipping, etc., that this was one of the most violent storms experienced here for many years. From facts already known concerning other points along the coast of Japan, it would seem that, had an efficient system of observations, telegrams, and signals existed, timely warning might have been given of its approach, and possibly much property and many lives saved. In view of this fact it appears hardly necessary to repeat the suggestion, the importance of which has been frequently urged in these columns, that the Government should, at the earliest practicable moment, inaugurate an efficient and complete signal service for the benefit of the whole country.—*Japan Weekly Mail.*

# ARTIFICIAL HYPNOTISM.

By Dr. R. HEIDENHAIN,
OF THE PHYSIOLOGICAL INSTITUTE OF BRESLAU.

THE people of the city of Breslau were, several months ago, greatly excited over the performances of a professor of animal magnetism who seemed to exercise extraordinary power. His subjects were taken indiscriminately from his audiences, and all, even physicians and men of science, who allowed themselves to be experimented upon, yielded to his control and contributed to his triumph. Dr. R. Heidenhain, Professor of Physiology and Director of the Physiological Institute of Breslau, on the invitation of the friends of science, delivered a lecture on the subject, in which he undertook to give a physiological explanation of the strange effects obtained by the magnetizer, and showed by experiment that the same results could be obtained by the sight or presence of inanimate objects. The following is an abridged translation of this address.—[Ed.

One of the essential symptoms of the hypnotic sleep is the more or less complete loss of consciousness. It is only in a complete state of hypnotism that persons subjected to the experiment preserve a remembrance of what has passed during their sleep. In some cases the memory is only suspended, and on awaking we may be able to revive the recollection by evoking an association of ideas which will put the subject in train. Sensorial perceptions take place even in the most complete hypnotism, but the power of transforming them into conscious representations, and consequently of fixing them in the memory, is absent. Have we not often had experience in the waking state of external perceptions which did not pass the threshold of consciousness because our attention was absorbed or distracted at the time? Have we not heard words pronounced around us to which we attached no meaning, which were nevertheless perceived by us, if we may speak in that manner, without our knowledge, since we may call them to mind by an effort of memory, provided they have not yet been effaced by a more recent impression?

The immediate affection of the senses and conscious perception are distinct physiological conditions, the latter of which supposes a holding of the attention. As the hypnotic's faculty of perceiving a sensation declines, his power of being conscious of it diminishes in a corresponding degree. Then, sensorial impressions which do not excite consciousness give way to movements which are accomplished almost without our control. A person walking in the street, absorbed in his thoughts, receives the visual impression of the passers-by on his retina without paying attention to them, and unconsciously performs the movements

necessary to avoid hitting them. The hypnotic is in a similar situation. Sensorial impressions of which he is not conscious provoke apparently voluntary and reasoned acts.

The hypnotic, although his eyes are shut, perceives what is passing around him. The eyelids are not wholly closed. Movements perceived unconsciously, by the aid of the sight or hearing, are imitated by him involuntarily and under a constraint from which he can not withdraw himself, and with an almost servile exactness. Thus he will regulate his step according to that of the experimenter who makes him act, will raise his arm to the same height, will bend his body back and forth in accord with his model.

Some acts of imitation, such as yawning, laughing, crying, etc., take place even in the normal condition; generally the idea of a movement determines the action, but in induced sleep the contrary takes place, and the unconscious perception of a movement leads to its accomplishment. This relation explains the facility with which hypnotics are made to execute movements of which what we may call the sensation has been communicated to them in advance. If the subject is not disposed to follow the experimenter when he walks briskly in front of him to excite him, the operator has only to draw him lightly by the hand to make him follow with docility. We have thus explained the secret of the power which the magnetizer exercises over his subject. The former gives an order which the hypnotic does not apprehend, but which he executes nevertheless if he has unconsciously experienced a sensorial impression corresponding with the action which is commanded of him. In testing whether the hypnotic, after waking, remembers what has passed, it is important that he be not assisted by being asked a question the form of which will suggest the answer. If he is asked if he remembers any particular thing, his answer will always be "Yes"; but if he is asked, generally, what has taken place, he will answer that he does not know. The slightest allusion may cause the remembrance to revive; and unconscious traces may be recalled on the intervention of suggestive external excitations. The hypnotic condition, when divested of charlatanism, discloses a multitude of interesting physiological and psychological facts.

In a slight degree of hypnotism, the *sensorium commune* is still so free that the constraint of involuntary imitation does not exist. As long as consciousness is not obscured, the excitation of the motive apparatus by special sensations does not take place; but when consciousness disappears, the sensorial excitation becomes predominant. So profound states of unconsciousness may be produced that all traces of sensorial perceptions, and the possibility of executing automatic acts of imitation, will disappear. A more advanced symptom of hypnotism is painlessness. Sensibility returns with the cessation of the sleep. The exaggeration of the reflex excitation of the striated muscles is also striking and of surprising duration. A person who has been hypno-

tized preserves the reflex irritability for whole days and weeks after he has returned to the normal state. When this excitation is light, the contraction is limited to the superficial muscles. In this condition it is easy to induce certain groups of muscles to contract. By passing the finger several times over the fleshy part of the thumb we may cause it to bend toward the palm of the hand; we may cause the head to assume the position known as that of a wry neck by exciting the skin over the sterno-cleido-mastoid muscle with a few light passes.

We may act on more remote muscles by prolonging the excitation. A light rubbing of the inside of the thumb only brings its adductor and flexor muscles into play. A stronger excitation of the same surface brings into action the muscles of the forearm and the flexors of the other fingers, which bend strongly toward the hollow of the hand. The muscles of the elbow and shoulder will be engaged in their turn, and in a short time the upper limb will become motionless. Continuing the passes, we may, in a few seconds, cause the contraction to extend to the left shoulder; the cramp will then descend along the arm, the forearm, and the hand of the left side; the left thigh and leg will yield to the same influence; then the right thigh and leg, the masseters and cranial muscles. It is time to pause. A slight shock on the left arm will cause the contraction to disappear. We can also cause it to cease by quickly opening the fingers of one of the closed hands.

Great prudence is necessary in these experiments lest they be carried too far, and the respiratory muscles be affected. The rigidity of the muscles may be made so great in robust persons that it becomes extremely difficult to change the position of the limbs. They are stiff as a plank, and it is possible to rest an hypnotic by his head and feet alone on two chairs, and carry him around without his body bending.

The first objective sign of the approach of the hypnotic condition is a rigidness of the accommodative apparatus of the eye. The assistants are able to perceive this before the hypnotic can feel it subjectively. The distance to which vision extends diminishes; writing which can be read from a distance can be distinguished only at close sight. Remote points disappear from the field of vision. In a few moments the pupil dilates, and the ball of the eye appears to project. The complexity of these phenomena supposes an excitation of the sympathetic nerve of the neck, which sets in motion the dilator muscle of the pupil and the smooth muscles of the lids and the socket. The initial point of the excitation must then be sought in the spinal marrow, where the sympathetic fibers originate. Other parts of the spinal marrow are not long in being affected, as the respiratory nerves, and the breathing is quickened. The aspirations increase from four to twelve in a quarter of a minute, but the frequency of the pulse is not increased.

Some persons are disposed to hypnotism in consequence of their

nervous impressibility, and of the power which imagination exercises over their minds. Others seem to be rebellious against it, and it is necessary to prepare them for it. The contemplation of the glass button exacted by M. Hansen (the magnetizer at Breslau) is intended solely to promote this excitability. Dr. Braid, of Manchester, first demonstrated that the fixed view of inanimate objects provoked a condition akin to the cataleptic sleep. Persons put to this sleep by him became insensible to pain. Some retained a feeling of what passed; others lost it. Fixing the sight upon bright objects is attended by peculiar phenomena. The dazzling effect, the flow of tears, and the fatigue of the retina cause the images on the edges of the field of vision to disappear. The hand that holds the button becomes indistinct and the button fades away. Phenomena of contrasts are produced, and posterior images appear during the involuntary movements of the eyes. Certain feeble and monotonous sounds act in a similar manner to produce stupefaction. If we cause a person to sit with his back against a table on which a watch has been put, and tell him to listen to its ticking, he will in a few minutes fall into the hypnotic sleep, and will then imitate unconsciously the motions of the operator. The effect is especially prompt if the eyes are kept shut. Light and continuous excitations on the surface of the skin exert a similar effect. This is the property on which depend the manipulations of touch and the passes which the magnetizer makes along the face of the person whom he wishes to put to sleep. These passes produce peculiar sensations, partly of contact and partly of heat. The sensations of contact at a distance are produced by the oscillations of the air, which is disturbed by the hand of the magnetizer. These currents occasion an almost imperceptible feeling of prickling, of shuddering. The sensation of heat is provoked by the difference in the temperature of the hand, which has been warmed by exercise, and of the motionless face of the patient.

The reactions to the different excitations vary according to the individual. Some persons are more sensitive to an excitation of the skin; others to that of the hearing or sight. The organs in which stupefaction is first felt are also the first to return to consciousness if they are subjected to an energetic shock. The touch of a cold hand on the face, a word spoken aloud at the ear, a light brought suddenly before the eyes, are enough to break the charm. After the waking, the disposition to hypnotism persists in a latent form. One who has been put to sleep many times has only to imagine he is going to fall into that condition, to go to sleep really. He has only to sit down, shut his eyes, and think, to the exclusion of every other idea, of the torpor which is about to overtake him, for the phenomenon to have its full effect. There is needed, in a word, to produce this effect, an exclusion of all change of thought and images. Having become acquainted with this disposition, we can produce effects which will be really inexplicable to

common people. We have only to tell a person who has been recently hypnotized that he will go to sleep at a certain hour, or in a certain place, or while doing a certain thing, for the phenomenon to be produced naturally.

The subject may be made to repeat words spoken before him, by pressing on the nape of his neck. Pressure between the fourth and seventh vertebræ of the neck makes him groan; when applied at the side of the last vertebra, it induces him to draw his leg back; and if made alternately on each side of this vertebra, will cause him to walk backward. Reflex local movements are provoked by the excitation of determinate points of the trunk: raising of the arms over the head, by irritation of the skin of the dorsal region of the pectoral vertebræ; turning of the arm backward, by excitation of the skin over the middle vertebræ. If we apply a hearing-trumpet to the nape or the stomach of a hypnotic, he, although he may have been insensible to words pronounced in his ear, will comprehend articulate sounds and repeat them, even though they be in a language that is unknown to him. Hallucinations are produced only if the provoked sleep is light. The hypnotic symptoms may be dissipated by suddenly changing the excitation. If the magnetic state has been produced by passes before the chin, it can be made to disappear by reversing them. The contraction of the arm caused by rubbing the inside of the thumb ceases when the direction of the current is changed. A new sensation dissipates the effect of a previous excitation. It is not, then, a matter of indifference whether we change the direction of the passes: we should persevere in the one which was adopted in the beginning. Rigidity, if it is not intense, ceases on the application of a cold body; a piece of money, a bit of glass, is enough to dispel it. If we touch the forehead or eyes of a hypnotic with a small piece of glass, he will open his eyes and mouth while sleep continues.

It has been asked if we can not obtain semilateral hypnotic phenomena by acting on half the face or head. In fact, by pressing along one side of the forehead or the crown of the head, we may diminish or suspend the influence of the will on the extremities of the opposite side. Light pressures on the left side of the head have produced immobility of the right arm and leg. A shock on the left arm caused this half-paralysis to disappear. The fixed limbs kept indefinitely the position which had been given them, and were found to be in a state of cataleptic suppleness. There appeared at the same time an impossibility to pronounce a word—a condition of ataxic aphasia. Passes on the right side of the head caused the same symptoms, less the aphasia, to appear on the left. Simultaneous passes on both sides of the head developed the cataleptic condition on both sides, aside from the disorder of speech and the facial movements. In all these experiments consciousness was preserved, without the accompaniment of any painful subjective impression. Lateral passes on the skin of the thigh pro-

duced singular disorders in certain sensorial impressions. The arm which was made cataleptic did not perceive the difference between a warm and a cold temperature. The eye on the affected side suffered a cramp of the accommodative muscle, and lost at the same time its normal sensitiveness to colors. The hypnotic condition can be explained only by hypothesis. All that is certain about it is, that it is due to a modification of the nervous centers of the brain and spinal marrow.

The apparently voluntary motions of persons in this condition are independent of their will, the sensorial impressions acting directly on their motive apparatus.

## EXAMINATION OF THERMOMETERS AT THE YALE OBSERVATORY.

By Dr. LEONARD WALDO.

ONE of the most useful institutions to science in England is the Kew Observatory of the Royal Society, whose principal work for the last quarter of a century has been to furnish accurate comparisons of thermometers sent there by physicists, meteorologists, physicians, and instrument-makers. The recognized benefits accruing to the scientific world from this well-known and widely popular service at Kew have caused the managing board of the Winchester Observatory of Yale College to organize a service having the same ends in view under the direction of the observatory. Although this work is but fairly commenced, yet it has met with most gratifying success, and there have been so many inquiries as to the methods and scope of this service that the writer has ventured upon a description suitable for the pages of the "Monthly," with the hope that in this form it may the more readily come to the notice of the meteorologists and physicians who are the most likely to be benefited by it.

Few are aware of the errors found to exist even in the thermometers of reputable makers. The well-known change which takes place with age in every thermometer not infrequently amounts to a degree and a half Fahrenheit within two years from the time the thermometer is made. The change depending upon the temperature to which a thermometer is heated, even supposing this to be no greater than the boiling-point of water, may be three fourths of a degree. If we add to these two sources of error the original error in the graduation of the thermometer scale arising from the boiling and freezing points not being properly fixed, and the error arising from the variations in the size of the capillary tube, it is quite within the range of possibility that thermometers, which from their general construction would appear

likely to give correct indications, may really be in error two or three degrees Fahrenheit at some part of their scales. Thus the "fever" thermometers in general use by physicians are almost invariably too high in their readings. An analysis of the results of sixty-eight thermometers of this description, verified in June of this year, will show how great this error may come to be: one fifth had errors less than 0·1°; one fifth had errors less than 0·4° but more than 0·2°; two fifths had errors less than 0·7° but more than 0·4°; one fifth had errors less than 1·0° but more than 0·7°; and occasionally a thermometer was found which had errors exceeding 1° and more rarely one exceeding 2°. The thermometers on which the above deductions rest were chosen to represent seven makers, and may be fairly taken to indicate the liability to error in using fever-thermometers which have not been compared with authoritative standards. It is not unlikely that members of the medical profession have been sometimes misled by the readings of inaccurate thermometers, and they may have made such unfavorable statements regarding the chances of recovery of patients whose temperatures were high, that the patient, under the influence of his imagination, has given up the struggle for existence when a little more hopeful view of the case might have imbued him with fresh courage and led to ultimate recovery.

The work at the Yale Observatory divides itself into two parts—the establishing of the standard thermometers with which thermometors sent to the observatory are to be compared, and the work of comparing thermometers. The investigation of the standards themselves is by far the most tedious of the two; and as the methods used in studying the observatory standards are also the methods used, with greater or less detail, in investigating the higher grades of thermometers sent to the observatory, the methods will be briefly outlined.

It will be necessary to recall some of the fundamental principles of thermometry, however, in order to properly comprehend the methods of procedure in the case of standards:

1. Glass mercurial thermometers slowly increase their freezing-point readings as their age increases after the heating they undergo in filling with mercury in their manufacture.

2. The readings of the boiling-points are also increased, but in a much less degree—perhaps not more than one fifth as much as the freezing-point.

3. Whenever the thermometer is heated at all, the freezing-point is lowered, and the amount of this depression is very nearly proportional to the square of the temperature to which the thermometer is heated.

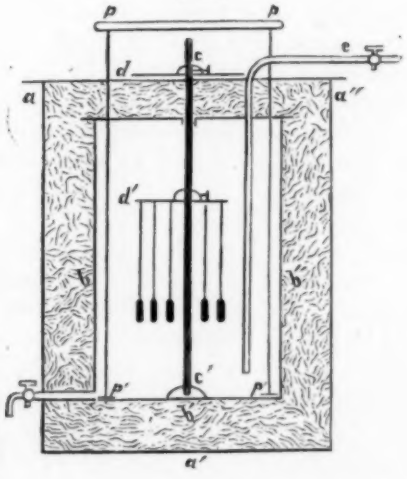
4. It follows from 3, that if a thermometer is kept at the ordinary temperatures, the freezing-point of water will be indicated by a lower scale reading than if the thermometer is kept at a low temperature. Now, if we suppose the thermometer has been kept at the freezing-point of water for a period of several days, and that the progressive

change which takes place in the first years after manufacture has ceased, the freezing-point which is then determined is called the permanent freezing-point, and is the zero of the Centigrade scale, or 32° of the Fahrenheit scale. If we heat the thermometer to the boiling-point of water, and then immediately cool it and immerse it in melting ice, we shall obtain another point on the thermometer scale which we may call the temporary freezing-point, because it will gradually approach the permanent freezing-point, and after a few months, if the instrument is not again heated, it will finally coincide with it. The difference between the permanent and temporary freezing-points is usually about three fourths of a degree Fahrenheit, and, so far as now known, remains constant for the same thermometer.

5. The boiling-point of water at the level of the sea, and with a barometric pressure of 760 mm. = 29·922 inches in the latitude of 45°, is the second point in the thermometer scale to be fixed. To do this the thermometer is exposed to the steam of pure water, and, from the observed height of the barometer, the known elevation and latitude of the place of observation, the true boiling-point is computed from the observed one, and the 100° C. or 212° F. is thus fixed.

6. Having thus located the freezing and boiling points of a standard thermometer, the intermediate points are to be fixed by dividing the scale so that at every part the length of 1° shall measure an equal

FIG. 1.




volume of mercury. At least, this has been the usual procedure, and for ordinary standards perhaps it is the most convenient. For standards to be used in the highest class of work it would be better to graduate the distance between 0° and 100° C. into one hundred equal parts, and then allow the observer to accurately determine the value of the corrections at each degree. Indeed, it is preferable for many

researches that the whole scale be simply a millimetre one, and care only be taken to have the millimetre graduation extremely accurate.

The dividing of the tube so that an equal volume of mercury may occupy the same number of degrees at the various parts of the tube is called the calibration of a thermometer, and on the perfection of this work, if it is attempted at all, largely depends the value of the thermometer. As Pernet has remarked, the labor of determining the errors of a thermometer is much increased by having to determine the errors the maker has introduced in the imperfect calibration of its scale. In observations not requiring an accuracy beyond 0·1° F., it it might be quite safely left to the skill of a reputable maker to free the instrument from errors of this kind. It is accomplished by detaching a small portion of the column and measuring its length at different, and usually consecutive, parts of the tube. Obviously from these results may be computed the value of 1° at successive parts of the thermometer scale, in terms of the dividing engine used by the maker.

The precision attained in the calibration of standards when the greatest care is exercised is surprising; thus, in the three Kew standards of the Yale Observatory, the maximum sum of the errors depending on imperfect calibration is very nearly 0.01° in each of them.

Supposing that several thermometers, by different and equally skillful makers, have been prepared with the greatest care, it is found in comparing them that they differ sensibly among themselves, owing to the difference in the glass used in their construction, their varying sensitiveness to the slight changes caused by the circulation of the water in which they are immersed, and a variety of less obvious causes. It becomes necessary, therefore, that some definite construction of the mercurial standard thermometer should be adopted, and the standard chosen by the Yale Observatory is defined upon the certificates issued with standards compared, as follows:

"The theoretical mercurial standard thermometer to which this instrument has been referred, is graduated by equal volumes upon a glass stem of the same dimensions and chemical constitution as the Kew standards 578 and 584. The permanent freezing-point is determined by an exposure of not less than forty-eight hours to melting ice, supposing the temperature of the standard has not been greater than 25° Cent. = 77° Fahr. during the preceding six months. The boiling-point is determined from the temperature of the steam of pure water at a barometric pressure of 760 mm. = 29·922 inches (reduced to 0° Cent.) at the level of the sea and in the latitude of 45°."

This standard has its 0° and 100° C. identical with the standard of the International Commission of Weights and Measures, and the physicists generally have agreed upon the pressure and latitude given as the most advisable. It is practically coincident with a pressure of 29·905 inches in the latitude of London, and at the sea-level—the con-

ditions under which the 212° point of the English standard is determined under act of Parliament.

A description of the Kew standards referred to is given in the accompanying table :

| Maker. | Maker's Number. | How Graduated. | Length of 1°. | Smallest Graduation. | Length of Tube. | Shape of Bulb. |
|---|---|---|---|---|---|---|
| Kew Observatory.. | 585 | — 34° to + 275° C. | 1·73 mm. | 1° | 618 mm. | Cylindrical. |
| Kew Observatory.. | 578 | — 9 to + 105 C. | 3·46 " | 0·5 | 455 " | " |
| Kew Observatory.. | 584 | + 14 to + 220 F. | 1·87 " | 1 | 455 " | " |

The tubes of which the Kew standards are made are about twelve years old, and belong to the series purchased by the Royal Society and deposited at Kew to be used as standards.

The essential parts of the water comparator in use at Yale for comparing thermometers is shown in outline in Fig. 1, where $a\ a'\ a''$ is a bright-tinned iron cylindrical tank 15 × 20 inches, having an aperture for the stopcock $f$, a lid $a\ a''$ with various apertures for the insertion of long thermometers, and having a plate-glass window 4×14 inches set in the side. Within this outer tank a smaller copper tank 11×15 inches is symmetrically placed, and rests upon wooden bars which are supported by the bottom of the outer tank. A window, placed in the same relative position as the outer window, allows the thermometers which are attached by springs at their upper ends to the adjustable brass disk $d'$, to be read. The brass axis $c\ c'$ turns in a bearing $c'$, and has attached to it two disks, $d$, $d'$. A small cathetometer with its telescope is placed before the windows, and the number of the thermometer under observation is shown by means of the graduated dial at $d$. Water of a given temperature is admitted through the tubes at $e$, and after the temperature has been brought to the degree required, it is thoroughly agitated by moving vertically the ring plunger shown at $p\ p\ p'\ p'$. The disk $d'$, which is perforated, will accommodate sixty-four thermometers. The agitation of the water having subsided, the thermometers to be compared are read as rapidly as possible, first from left to right and then from right to left. Two standards are read at the beginning and end of the series. It is obvious that, if they are read at approximately equal intervals, the mean of the two readings will be free from the error of radiation caused by the slow cooling or warming of the water. The greater part of the work of the observatory upon standards is done with this comparator. For clinical thermometers a smaller apparatus, constructed on the same general principles, is used ; but, as in this case a much less degree of precision is desired than in the investigations of standards, the work may be simplified. It is not necessary, for instance, to resort to the somewhat tedious read-

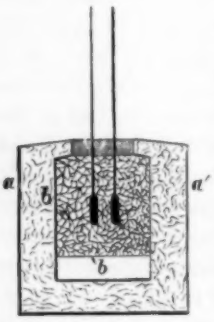
ings with the cathetometer, and since the thermometers are self-registering, they may be lifted from the water to be read.

The space between the outer and inner tanks is filled with cotton-wool which has been picked with the fingers until it has as little body as possible. The object of this wool is to prevent currents of air, which would otherwise cause a much greater conduction of heat to or from the body of water in the inner tank.

The determination of the freezing-points of standards is accomplished by the apparatus shown in Fig. 2, where *a a'* is a tinned-iron cylindrical vessel 9×9 inches, inclosing a smaller one 7½×5 inches. A strainer allows the water from the finely crushed ice or snow to escape into the open space *b'*, and the space between the outer and inner vessels is filled with cotton-wool. Close-fitting covers prevent currents of air from the outside, and when in use each thermometer is fitted to a cork which is imbedded partly in the ice.

One boiling-point apparatus is constructed after Regnault's plan, and consists essentially of a brass stand (Fig. 3) supporting a water-tank *w w'*, 6 inches in diameter and 3·5 inches deep, upon which in turn rests a brass section of double tubing having an inside diameter of 5 and an outside diameter of 6 inches. This section, which extends upward 3·1 inches, has three open tubes each 0·7 inch in diameter (*v v'*) let into its outer wall. At the place which would be occupied by the fourth there is a small manometer-tube *m*, with a stopcock *s*, by which the difference of the pressure of the steam inside and the air outside may be noted. Any one of a series of four brass double cylinders, ranging in height from three to twelve inches, may be fitted to this first section by a telescope-joint at will. Each of these double cylinders has perforations at its top for the insertion of thermometers. Around the top of the inner cylinder there is a series of ten holes, each three fourths of an inch in diameter, to allow the steam to pass from the inner chamber to the outer, and thus through the vents *v v'* to make its escape. When in use, the tank *w w'* is filled with pure water, taking the precaution to put several feet of brass ribbon in the bottom to equalize the boiling; and the heat is communicated by means of the Bunsen burner *b'*. The thermometers are suspended as at *t t'*, with their bulbs at *b*.

FIG. 2.

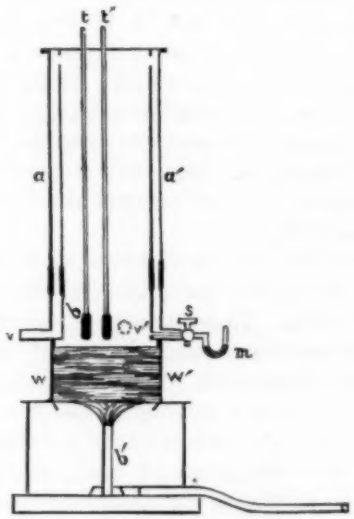



Another boiling-point apparatus, to be used for very long thermometers, and where it is desirable to take the greatest care in the boiling-point determination, is made entirely of glass. The thermometer is completely immersed in steam, and the readings are made with the cathetometer by looking through the glass and steam which surround the thermometer.

A standard barometer, wrapped in cotton-wool and cloth to prevent rapid change in the temperature of its mercury, and made by James Green, is hung on the same level as the boiling-point apparatus, and the thermometers are read alternately with the barometer. The cathetometer is used for reading thermometers in both the boiling and freezing-point apparatus.

For the calibration of tubes, two microscopes have been mounted so that the position of the two ends of a short mercury-column may be

Fig. 3.




read at the same time by means of eye-piece micrometers. The observatory is having built a comparator especially for this work, which will soon be mounted in its place.

By far the most valuable apparatus in connection with this work is the collection of foreign standards which have been obtained to represent the work of foreign observatories. This collection comprises seventeen standards of the highest class, eight working standards, and forty-five comparison thermometers. The makers comprise noted artists of Europe, and among them are the Kew Observatory; Baudin, Fastré, Tonnelot, and Alvergniat, of Paris; Fuess, and Greiner & Geissler, of Berlin; and Casella, of London.

The comparison of the important standards was undertaken by the Kew Observatory in England, the Seewarte at Hamburg, and the Imperial Commission of Weights and Measures, under Dr. Foerster, at Berlin. There can be little doubt, therefore, that the observatory of Yale College possesses an accurate copy of the standard thermometers now in use in the prominent observatories in Europe.

It is the object of the observatory to make this service as widely

popular as possible; and it particularly desires to be useful to the physicians, meteorologists, and the commercial manufacturers who have occasion to use fairly accurate thermometers. The testing of illuminating oils, the manufacture of spirits and ethers, and the numerous operations of the chemical laboratory, require thermometers of considerable accuracy, and for the benefit of persons using such the observatory has issued a circular which will be mailed on application.

Thermometers may be sent by mail or express, directed to the Winchester Observatory, New Haven, Connecticut. If they are sent by mail (and nothing larger than a clinical thermometer should be), they ought to be packed in a wooden box, in tissue-paper. In whatever manner they are sent, a little care taken in packing them in soft paper will materially lessen the risk of accident. Ordinary thermometers are returned to the senders, with certificates stating their deviation from the true mercurial standard for every ten degrees, within a few days from the date of their reception. Standards require from a week to a month for their investigation, depending upon the degree of precision desired in the final certificates.

The official circular of the observatory contains detailed information relating to the supervision of hospital thermometers and the facilities offered to makers. There is no good reason why any maker should not furnish, with any thermometer sold, a certificate stating the errors of that particular instrument. That the service will be a popular one is shown by the fact that already about five hundred thermometers have been sent to the observatory for verification, and not the least benefit will be that the errors of every thermometer issued with a certificate will be on file at the observatory, and this will be of particular value in cases where a uniformity of data is desired, as in the case of the United States Signal Service, or the observations made by isolated meteorologists in different parts of the country.

## INDIGESTION AS A CAUSE OF NERVOUS DEPRESSION.

By T. LAUDER BRUNTON, M. D., F. R. S.

II.

BUT bile is not the only substance which produces a depressing effect upon the circulation when absorbed into it from the portal system. I have already mentioned that certain albuminous products of intestinal digestion and peptones occasionally make their appearance in the urine. Among the former is an albuminous substance, not precipitated by boiling, but by nitric acid in the cold. This sub-

stance I have observed in the urine of a healthy man after he had drunk a large quantity of strong beef-tea at a draught upon an empty stomach. My attention was drawn to the urine by the froth remaining upon it for a somewhat unusual time. On examination, this substance was discovered in it. On examining the beef-tea which the person had taken, a similar albuminous substance was found in it, so that there can be little doubt that in this case the albumen was simply absorbed so rapidly from the stomach or intestines that it passed without change through the portal system into the general circulation, and thus reached the kidneys, where it was excreted in much the same way as sugar would have been under similar circumstances. We find only too frequently that both doctors and patients think that the strength is sure to be kept up if a sufficient quantity of beef-tea can only be got down; but this observation, I think, raises the question whether beef-tea may not very frequently be actually injurious, and whether the products of muscular waste which constitute the chief portion of beef-tea or beef-essence may not under certain circumstances be actually poisonous. For although there can be no doubt that beef-tea is in many cases a most useful stimulant, one which we find it very hard indeed to do without, and which could hardly be replaced by any other, yet sometimes the administration of beef-tea, like that of alcoholic stimulants, may be overdone, and the patient weakened instead of strengthened. In many cases of nervous depression we find a feeling of weakness and prostration coming on during digestion, and becoming so very marked about the second hour after a meal has been taken, and at the very time when absorption is going on, that we can hardly do otherwise than ascribe it to actual poisoning by digestive products absorbed into the circulation. From the observation of a number of cases I came to the conclusion that the languor and faintness of which many patients complained, and which occurred about eleven and four o'clock, was due to actual poisoning by the products of digestion of breakfast and lunch; but at the time when I arrived at this conclusion I had no experimental data to show that the products of digestion were actually poisonous in themselves, and only within the last few months have I seen the conclusions to which I had arrived by clinical observation confirmed by experiments made in the laboratory. Such experiments have been made by Professor Albertoni, of Genoa, and by Dr. Schmidt-Mühlheim, in Professor Ludwig's laboratory at Leipsic.

Professor Albertoni has found that peptones have a most remarkable action upon the blood, completely destroying its coagulability in dogs, while they have little power in this respect over the blood of rabbits or sheep. The number of species upon which he experimented is limited, so that he can not as yet draw the conclusion with certainty that peptones prevent the coagulation of the blood in carnivora and not in herbivora, although, so far as experiments go, this conclusion seems probable. He and Dr. Schmidt-Mühlheim independently made

the discovery that peptones prevented the coagulation of the blood in dogs, and the latter, under Ludwig's direction, has also investigated their action upon the circulation. He finds that, when injected into a vein, they greatly depress the circulation, so that the blood-pressure falls very considerably; and when the quantity injected is large, they produce a soporose condition, complete arrest of the secretion by the kidneys, convulsions, and death. From these experiments it is evident that the normal products of digestion are poisons of no inconsiderable power, and that if they reach the general circulation in large quantities they may produce very alarming, if not dangerous, symptoms.

Such experiments as this open up a new and very wide field of inquiry, which is likely to prove of very great practical importance. We have hitherto been accustomed to reckon all peptones as identical, by whatever digestive ferment they were formed, and to look upon it as a matter of slight moment whether albuminous foods introduced into the digestive canal were dissolved by the stomach or by the pancreas, although it is quite possible that the peptones differ as much from each other as different kinds of sugars. It is a matter of wonder, also, that at the present moment, although the digestive processes have been so carefully investigated, we know very little of the uses of the *succus entericus*. Notwithstanding the great extent and evident importance of the intestine, and the large quantity of fluid which it is able to secrete, all that we find regarding the action of this secretion in such a book as Foster's "Physiology" is that "the statements with reference to its action are conflicting. Probably it has no direct action on either fats or proteids, but is amylolitic in some animals, though not in all." *Succus entericus* has also been said to change cane- into grape-sugar, and by a fermentative action to convert cane-sugar into lactic acid, and this again into butyric acid, with an evolution of carbonic acid and free hydrogen. The reason why experiments on the action of intestinal juice have given such an apparently unsatisfactory result is that they have been chiefly tried on such kinds of food as we are accustomed to put into our mouths. Now, the intestinal juice is not intended to act upon such substances: its place is to finish the digestion begun by the other juices; and when experiments with intestinal juice are tried upon foods which have previously been subjected to the action of the other digestive fluids, positive and not negative results are obtained. Thus, for example, it was stated by Kühne, in his lectures at Amsterdam in 1868–'69, that though intestinal juice would dissolve raw albumen and fibrine, it would not act at all upon them if boiled; but if the boiled albumen or fibrine were first subjected to the action of pancreatic juice for a short time, the intestinal juice would afterward dissolve them much more quickly than it would even in a raw condition. The action of digestive ferments is just beginning to find a practical application in medicine, and sometimes, undoubtedly, they are of very great service; but unless their action is investigated

more thoroughly than it has been up to the present, it is just possible that we may by and by find that the digestive ferments, like all other powerful agents, may do much harm as well as much good. Hitherto we have been accustomed to regard the phases of digestion, gastric digestion, pancreatic digestion, and intestinal digestion, as almost separate processes, any of which we might increase indefinitely without doing any harm to the patient. We forget the relation which each bears to the other; and yet such a relation undoubtedly exists, for we find that when pepsin is mixed with bile it is precipitated and rendered inert. Further transformation of foods by the gastric juice is thus arrested as soon as the chyme leaves the stomach. And well it is that this should be so, for if the pepsin were not rendered inert it would destroy that pancreatic ferment (trypsin) which acts on albuminous substances, and thus interfere with digestion by it. How far this prolonged peptic digestion and impaired pancreatic digestion of albuminous substances has to do with the production of poisonous digestive products in cases where the quantity of bile poured into the intestine is deficient it is at present impossible to say, but it is a condition which ought to be kept in mind in all cases where there is deficiency of bile in the intestine, and the advisability of nourishing the patient by farinaceous food is constantly considered in these cases.

And now comes the question, How is it that in healthy conditions of the intestine peptones do not pass into the general circulation, and are therefore unable to exert any poisonous action upon the nerve-centers? This question is one which we can not at present answer quite satisfactorily.

Usually the peptones disappear from the portal blood before it reaches the general circulation. Indeed, Ludwig and Schmidt-Mühlheim found that even in the portal blood, before it reaches the liver, very little if any peptone is to be found. They have not succeeded in discovering where the peptone undergoes change. Plósz and Gergyai, and also Drosdorff, have discovered peptone in the blood of the portal vein, and Plósz and Gergyai have been led, by their experiments, to regard the liver as the seat of the transformation of peptones. In consideration of the more recent experiments of Ludwig and Schmidt-Mühlheim, we can not entirely adopt the view of these authors, though it is nevertheless possible that they are to a certain extent right, and that the liver, to some extent at least, serves the purpose of preventing any peptones from getting into the general circulation, which may have escaped transformation in the portal blood before reaching it.*

And now, having run over in this cursory manner some points connected with digestion and with the functions of the liver, we come back to the question of why it is that the mental worker becomes de-

* Schmidt-Mühlheim, "Archiv für Anatomie und Physiologie; physiologische Abth.," 1. & 2. Heft, 1880, p. 33. Albertoni, "Centralblatt f. d. medicinischen Wissenschaften," 1880, p. 577.

pressed, irritable, melancholy, and, it may be, stupid and forgetful, after a few months' work, although every part of his body may be organically healthy, and a month's holiday may be sufficient to restore every organ to perfect functional activity? One reason, no doubt, may be that his systematic overwork may produce a diminution in the energy-yielding substance of his nerve-centers, just as we see that a certain amount of atrophy occasionally occurs in overworked muscles. But this does not seem very probable. It seems much more likely that they cease to act in the normal way because, during each day's activity, a certain amount of waste product is formed which is not perfectly removed during the hours of rest.

All throughout the body we have most elaborate arrangements for removing waste products. In the muscles, for example, we find that the fascia which surrounds them forms a regular pumping arrangement, the two layers of which it consists being separated from each other at each muscular relaxation, and pressed together at each contraction.* The lymph and the waste products which it contains are thereby actually pumped out of the muscle at each contraction, and sent onward into the larger lymph-channels, so that the muscular action itself removes the waste products. At the same time we find that the movement of the muscles of the leg, for example, will also pump out the blood from the veins, sending it upward from the feet, and pressing it upward to the body.†

Again, we find that in the abdomen and thorax we have pumping arrangements, whereby any excess of the serous fluid which bathes the intestines and lungs is pumped out of the peritoneal pleural cavities by the action of respiration. The two layers of the central tendon of the diaphragm and of the pleura here form pumping arrangements similar to the fascia in the leg.

The brain and spinal cord, being inclosed in rigid cases, have no pumping arrangements in immediate connection with them, but the circulation of the cerebro-spinal fluid in them is probably affected also by the movements of the thorax and abdomen. The cavity of the arachnoid and of the cerebral ventricles is not only continuous with similar cavities in the spinal cord, but also with the lymph-space surrounding the choroid, with the interior chamber of the eye, and even with the lumbar lymphatics; and Professor Schwalbe has succeeded in injecting these parts by a single insertion of the nozzle of his injecting syringe into the arachnoid. His observations have been confirmed and extended by Althann.‡ The experiments of Quincke have shown that during life a current exists in the cerebro-spinal fluid, both from above downward and from below upward.§ The cause of this current

* Ludwig and Genersich, p. 53, "Ludwig's Arbeiten," 1870.

† Braune, "Ber. der sächs. Gesell. d. Wiss.," 1870, p. 251.

‡ Althann, *vide* "Virchow's Jahresbericht," 1872, p. 156.

§ Several authors, as Abel Key and Retzius ("Nordisk medicinsk Arkiv.," 1870,

is, in all probability, the respiratory movements. We have, indeed, in the brain and spinal cord, a condition not unlike that which exists in the fascia covering muscles, where the muscular substance during its contraction presses flexibly the inner against the unyielding outer layer of the fascia, and thus produces, in the space between them, a pumping action. The skull and vertebral canal would correspond to the hard outer layer or fascia ; and the brain and cord, which, as we know, expand and retract during the movements of respiration, when a part of their bony case is removed, will have a similar pumping action upon the cerebral spinal fluid to that of the muscle upon the lymph in the fascia.

In the case of the brain and the cord there will be, in addition, a pumping action produced by the very circulation of the blood in them, the alternate expansion and dilatation corresponding to the heart's beats, having a similar effect to that produced by the respiratory movements. As stimulation of the brain causes dilatation of its vessels, and increases the flow of blood through them, mental action of itself not only attracts more blood to the brain, but provides to some extent for the removal of waste products. The movements induced by the cardiac pulsations are not so extensive as those caused by the respiratory movements or by muscular exertion, and therefore, when the brain is overworked, and the respiration and muscular movements are underworked, the cerebral nutrition will be diminished by the imperfect removal of waste from its substance. But if, in addition to this, the cerebral cells and fibers are actually poisoned by the circulation within the vessels which supply them, of noxious substances due to imperfect digestion or assimilation, matters will become very much worse.

We have already seen how much the liver has to do with such a condition. Now, while the brain is being taxed to its utmost, the worker generally gets but very little exercise. The consequence of this is, that although the respiratory movements still go on with regularity, and the pressure of the diaphragm upon the liver at each respiration presses the bile more or less out of the liver, yet the pressure thus exerted is very much less than would be the case if the individual were making occasional vigorous efforts during which the breath was held, and the muscles of the abdomen put into action, as, for instance, in springing from bowlder to bowlder on the moraine of a Swiss glacier. So long as the brain-worker is exceedingly careful what he eats, so that no excess of bile is formed, and is fortunate enough to escape duodenal catarrh, so that no impediment, however slight, prevents the flow of bile into the intestine, he may get along perfectly well ; but if he be unfortunate enough to get what is commonly known as cold in

II, 1, 13–18; "Centralblatt für Medicinischen Wissenschaften," 1871, p. 514); Quincke ("Reichert's und Du Bois-Reymond's Archiv," 1872, 153–177; "Centralblatt für Med. Wissen.," 1872, p. 898).

the stomach, or unwary enough to irritate the mucous membrane of his stomach or duodenum by wines or spirits, the case is at once altered, for now the swollen mucous membrane of the duodenum tends to close the orifice of the bile-duct, or the congestion may even extend up the duct itself. Thus an impediment, however slight it may be, is opposed to the exit of bile from the liver. The pressure under which the bile is secreted, as I have already said, is very small, and there being no extra pressure put upon the liver by the diaphragm and abdominal muscles, instead of the bile being at once forced out of the bile-capillaries it will remain in them, causing more or less congestion, and now follows a whole series of disagreeable results. The bile, which may be looked upon as a waste product of the liver, not being removed, the other functions of the liver are disturbed. Assimilation becomes imperfect, we find lithates appearing in the urine; the circulation in the liver itself may be altered, and thereby the whole circulation in the stomach and intestines may be impeded, for it must be remembered that all the blood from the stomach and intestines has to pass through the liver before it again reaches the general circulation. Thus the individual becomes troubled with hæmorrhoids, secretion and vermicular movement in the bowels are impaired, so that constipation results; congestion of the stomach, with loss of appetite, impaired digestion, and flatulent eructations ensue, and the brain and nervous system begin to suffer from the accumulation in them of their own waste, or the absorption of abnormal products of assimilation.

Feeling weak, dull, and melancholy, the sufferer now thinks he ought to take meat three times a day, and perhaps, during the intervals of his meals, to take strong beef-tea, or perhaps a glass of wine or a nip of brandy. Yet, in spite of all this, he becomes weaker, more stupid, and more melancholy; and no wonder. He is simply further overtaxing his already overworked digestive organs. He is piling up fuel, instead of removing ash, and choking the vital processes both in his digestive and nervous systems. What he wants is not more nutriment, but a more rapid removal of waste, and the change upon the adoption of a proper system of treatment is in many cases most marked and satisfactory, both to the physician and the patient.

The first thing to be done is to clear out the liver. This may seem to be an unscientific expression, one adapted rather to popular notions than in accordance with ascertained facts. But this is not the case. In a former paper on the action of purgative medicines,* I have explained the way in which certain purgatives may be said to have the effect of clearing out the liver, and first among those we must reckon mercurials. In the case which we have just been describing, five grains of blue-pill may be taken every night, or two or three grains of calomel either alone or combined with extract of hyoscyamus or conium, and this should be followed next morning by a saline draught.

* "Practitioner," vol. xii, pp. 342, 403.

As a saline we may use sulphate of magnesia, or Friedrichshall, Pullna, Hunyadi Janos, or Carlsbad water; but, whichever saline we may choose, the use of one or other of them should on no account be omitted. One of the best salines is half a drachm of crystallized Carlsbad salts dissolved in a tumbler of hot water and drunk immediately after rising in the morning, and this may be used not merely in the morning after the mercurial, but it may also be employed every morning in cases where the bowels are constipated. The quantity of water is of considerable importance. Half a teaspoonful dissolved in a full tumbler is more efficacious than double the quantity of salt in half the quantity of water. Nor is this to be wondered at, for not only has the larger quantity of liquid greater power to wash out the intestine, but the increased amount of the water tends to increase the quantity of bile secreted, and this increase in bile is especially marked when the water is taken frequently in small quantities, as it is by persons undergoing the cure at Carlsbad, or who take the solution of Carlsbad salts at home by sipping it at intervals while dressing, instead of drinking it all off at once.

Zawilski found that when liquids were taken in this way not only was the bile secreted in greater quantity, but under a greater pressure, so much so that secretion still occurred when such an obstruction was opposed to its exit as would usually have caused the bile which had already been excreted to be reabsorbed.*

When the Carlsbad salts are employed after the mercurial, it is, I think, best to take them in single large draughts immediately on rising, but when used by themselves the solution should be sipped at intervals during dressing. When used alone, the Carlsbad water, warmed by standing the tumbler in a basin of hot water or in an ætna, is perhaps even better than the salts, which represent only a part of the normal constituents of the water. After the liver has been thoroughly cleared out in this manner by a mercurial purgative followed by a saline, vegetable cholagogues, such as iridin and euonymin, may be employed to assist the action of the Carlsbad salts, when these are found to be insufficient, even although they are taken with regularity. These cholagogues, the introduction of which into medicine, in this country at least, we owe to Professor Rutherford, are sometimes as useful, perhaps even more so than mercury, but, as a rule, I think the mercurial purgative is the best to begin with. Euonymin is the cholagogue most usually employed, but iridin is really the most powerful one, and is specially recommended by Dr. Rutherford.

Instead of trying to keep up the strength, as it is termed, by loading the stomach with food, the exhausted brain-worker should rather lean toward abstinence from food, and especially toward abstinence from alcoholic liquors. The feeling of muscular weakness and lassitude, which I have already had occasion to mention as frequently com-

* "Sitzungsber. der wiener Acad.," 1877; mat. nat. Abth., Bd. iv, p. 73.

ing on about two hours after meals, is not uncommonly met with in persons belonging to the upper classes who are well fed and have little exercise. It is perhaps seen in its most marked form in young women or girls who have left school, and who, having no definite occupation in life, are indisposed to any exercise, either bodily or mental. I am led to look upon this condition as one of poisoning, both on account of the time of its occurrence, during the absorption of digestive products, and by reason of the peculiar symptoms—viz., a curious weight in the legs and arms, the patient describing them as feeling like lumps of lead. These symptoms so much resemble the effect which would be produced by a poison like curare, that one could hardly help attributing them to the action of a depressant or paralyzer of motor nerves or centers. The recent researches of Ludwig and Schmidt-Mühlheim render it exceedingly probable that peptones are the poisonous agents in these cases, and an observation which I have made seems to confirm this conclusion, for I found that the weakness and languor were apparently less after meals consisting of farinaceous food only. My observations, however, are not sufficiently extensive to absolutely convince me that they are entirely absent after meals of this sort, so that possibly the poisoning by peptones, although one cause of the languor, is not to be looked upon as the only cause. A glass of soda-water, with or without the juice of a lemon squeezed into it, may be slowly sipped when the feeling of weakness comes on, and a biscuit may be eaten along with it if desired. This will sometimes relieve languor, but if it be found insufficient, a small cup of warm but weak tea or cocoa with a biscuit will act as an efficient stimulant, although they may be less unobjectionable than the soda-water. Heat is one of the most powerful of all cardiac stimulants, and any warm fluid in the stomach will increase its action; a cup of warm water alone will do this, but it is unpleasant to take, and so something must be added to flavor it: a little claret may be used if tea disagrees, or tincture of ginger and sugar, or even some Liebig's extract. It is the local action of the warmth that we want, and in order to obtain it we may sometimes have to put up with the inconvenience of giving substances which will be to some extent injurious after their absorption, such as beef-extract or even whisky. The advice that I have given here, in recommending a glass of cold soda-water or a cup of hot tea, may remind one of the countryman in one of Æsop's Fables who fell into disgrace because he blew upon the fire to heat it, and blew upon his porridge to cool it. And yet the countryman was right, for experience had taught him that the desired result would follow his actions, even though he might not be able to explain the reason why. So we find that a draught of cold water will revive a fainting person, and hot water will have a somewhat similar effect. Both of them give relief by stimulating the circulation, but their *modus operandi* is different. In the case of the hot water the circulation is stimulated

through the heart, which is excited to increased contraction, and thus the tension within the vessels is raised. In the case of the cold, the pressure is also raised, not by stimulation of the heart, but by the contraction of the vessels, especially those of the stomach and intestine. In the case of warmth, more blood is poured into the aorta by the excited heart, and where we apply cold less blood flows out of the aorta into the veins through the intestinal vessels, and thus it is that in both cases the tension is raised and the faintness removed.

At each meal it is well for the patient to begin with the solids before he proceeds to the fluids, and at breakfast, instead of beginning the meal with a cup of tea or coffee, he should finish a slice of dry toast and a piece of fish, egg, or bacon, before he takes any liquid at all. The same rule should be observed at lunch and dinner. The effect of this course is that the patient is less troubled with weight and flatulence after meals. The explanation of the fact probably is that the solids, entering the stomach first, stimulate it to secretion and movement; whereas, if it already contained a quantity of liquid at the time they were ingested, they would not have this effect, and imperfect digestion would be the result. At dinner, wine or beer may be taken if the patient finds them agree, but in all probability he will be better without them. There are some brain-workers who require them and must have them, but it is better for a good many others to avoid either wine or beer, and to take some effervescing water instead. Not unfrequently we hear the complaint that effervescing water is too cold, and where this is felt to be the case ginger ale or zoedone may be substituted, the color of these beverages and their more pungent taste rendering them more grateful both to the eye and the palate of many persons. In some cases weak claret-and-water may be used, and if the water be somewhat warm the mixture will be better for the patients, and will not cause the feeling of coldness in the stomach of which they sometimes complain.

A medicine which has long enjoyed a great reputation in disorder of the liver is nitro-muriatic acid, and I think this reputation well deserved. We do not know how it acts, but in some way or another it does tend to improve the digestion. Ten minims of the dilute nitro-hydrochloric acid, either before or immediately after meals, combined with some aromatic and carminative, such as chloroform and cardamoms or orange, and from five to ten minims of tincture of nux vomica, where the nervous depression is great, is a most efficient remedy.

But, even with all this care in food and drink, with all this attention to what is to be taken and what avoided, with medicine morning, noon, and night, how are we to keep the liver in order without exercise? Sometimes the patient may be able to take walking exercise, but when he does it is generally only for a short time during the day, and of so gentle a character that the respiratory movements are but

very slightly increased, and the liver is hardly more stimulated by the pressure of the diaphragm and abdominal walls during the walk than it would have been had the patient remained quietly at home. Time is an important element in many cases. Many a hard-worked man has his day so fully occupied that he can not give up more than a quarter or half an hour to exercise, and it is of importance that in this limited period he should get as much exercise as possible, and the best way to employ this brief time is by taking horse-exercise. I believe it is to the late Lord Palmerston that we owe the saying that "the outside of a horse is the best thing for the inside of a man," and it is very near the truth. A brisk trot for fifteen minutes will cause more pressure upon, and stimulation of, the liver than a lazy lounge of an hour or more. The time for this will depend in a great measure upon the engagements of the patient. It should not be taken immediately after a meal, and for most men whose days are fully occupied almost the only time to take it is before breakfast. A cup of milk, or a small cup of tea or coffee, with a piece of bread and butter or a biscuit, may be taken just before starting, and then the regular breakfast will be taken with greater appetite and better digestion after the exercise is over.

By careful attention to the removal of waste products, and to the prevention of absorption of poisonous substances from the intestine, by regulation of the diet, regulation of the bowels, and exercise, in the ways just mentioned, I believe that the nervous exhaustion and depression from which brain-workers suffer may be greatly diminished, even although it may not be entirely prevented.—*Practitioner.*

## OIL-PLANTS OF FRENCH GUIANA.

By Dr. J. HARMOND.

THE flora of Guiana includes a considerable number of plants of different families whose organs contain fatty matters. The most important of these plants, both on account of the abundance and quality of the oil it yields, is the carapa (*Carapa Guianensis*, D'Aublet; *Xylocarpus carapa*, Spr.; crabwood of the English), a plant of the family of the *Meliaceæ*, the family of which the Pride of India is the best known representative. It is one of the largest trees of the country, reaching a height of from sixty-five to a hundred feet, and a diameter of from a yard to a yard and a half. The wood is of a grayish or reddish color, and of excellent quality, is much in demand on account of the ease with which it is worked, and is used for shingles, cabinet, carpenter's and carriage work. The leaves are abruptly pinnate, with smooth, oval leaflets about a foot long and ending in a projecting

point. The fruits are round, four-valved capsules, about three inches in diameter, and grow in bunches. They inclose a white, solid kernel of irregular shape and firm consistency. To get the oil, the natives boil the kernels in water and let them stand in a heap for a few days. They then peel them, crush them with stones or pound them in wooden

FIG. 1.—CARAPA GUIANENSIS—FRUITS AND LEAVES (reduced).

mortars, and make a paste of them which they spread on a slab of stone hollowed out, and exposed at a slight inclination to the heat of the sun. The oil with which the paste is impregnated runs into a calabash which is placed to receive it. The negroes on some of the plantations put the paste into a bag and press the oil out with weights. The

carapa-tree appears to have been formerly more abundant in the inhabited districts than it now is, but it has been sought after on account of the qualities of its wood till it has nearly disappeared. It is still very abundant in the interior, where it grows near the rivers, and on moist lands. In some places, it is said, the ground is so thickly cov-

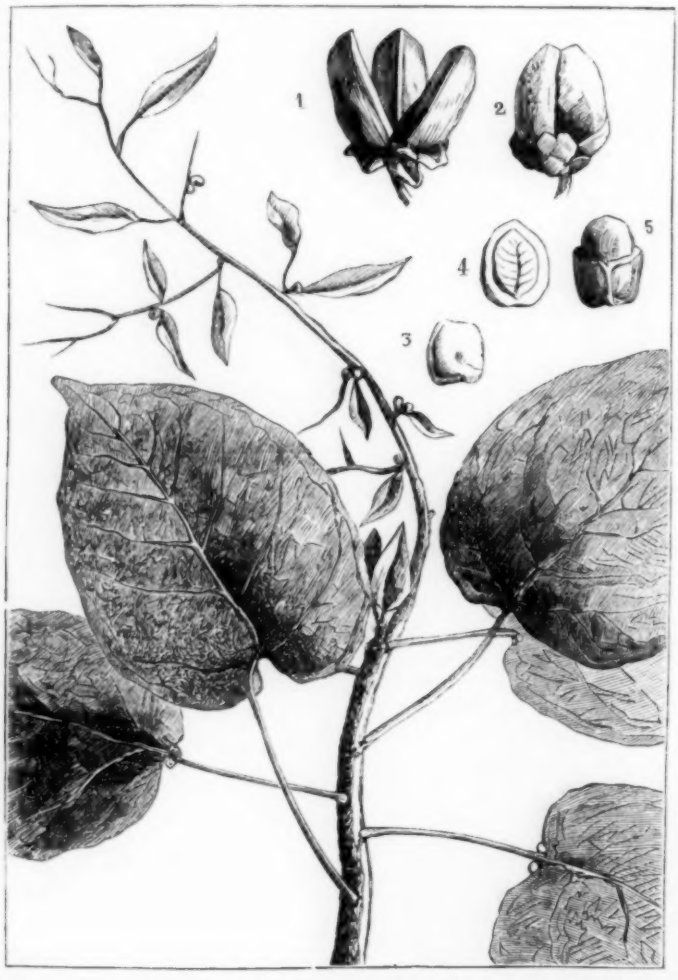



FIG. 2.—OMPHALEA DIANDRA (D'Aublet). 1, 2. Fruit, splitting into three nuts; 4. Internal face of cotyledon; 5. Nut with a part of the shell taken away, showing a part of the kernel.

ered with the fruits that they come up to the knees of a person walking among them. The principal crop is gathered between February and June or July. Another crop ripens in September and October, but the oil is of an inferior quality. The fruits do not keep well, but are subject to a mold which reduces them to dust, sprout readily, and are

greedily attacked by a grub and by microscopic enemies. The paste, too, is apt to spoil by heating. Hence it is found to be most economical to make the oil where the nuts grow. The nuts, when broken up with their coverings, yield about thirty-six per cent. of oil; cleared of their coverings, the kernels give sixty per cent. When cold-pressed, the oil is clear and amber-colored. When left to stand, it gives a solid deposit of a crystalline appearance. It makes a soap of excellent quality, and having a certain degree of hardness—a property which makes it valuable to mix with other oils that give too soft soaps. When refined, it makes an excellent lubricating oil, and gives a light that leaves nothing to be desired. The catalogue of the Permanent Exposition of the French Colonies names some fifteen other species of plants the fruits of which yield oils. One of the most valuable of them is the *Omphalea diandra* (D'Aublet), a large vine of the Spurge family, which bears seeds with very hard and black, horny shells. The shells are used for making beads. The kernel contains a very limpid, amber-colored oil, which is excellent for illumination, for making soap, and for lubricating purposes, and of which the yield is 64·58 per cent.

## CRITICISMS CORRECTED.

By HERBERT SPENCER.

### III. GUTHRIE AND BIRKS.

CRITICISM would be greatly diminished in bulk if there were excluded from it all that part devoted to disproving statements which have not been made; and were this course pursued, the work "On Mr. Spencer's Formula of Evolution," by Malcolm Guthrie, would disappear bodily. It is little else than a misstatement of certain fundamental views of mine, and then an elaborate refutation of the views as misstated.

Let me first show by brief extracts from "First Principles" what these views are. In a chapter on "Ultimate Scientific Ideas," after showing how the hypothesis that matter consists of solid atoms commits us to alternative impossibities of thought, I have shown how the hypothesis of Boscovich, that matter consists of centers of force without extension, is unthinkable. In the course of the argument I have pointed out that though Boscovich's hypothesis can not be realized in thought, yet, on the other hand, the hypothesis of extended atoms itself implies an imaginary separableness of each atom into parts, and again of these into parts, and so on without limit until unextended centers of force are reached: the consciousness of force being that which alone perpetually emerges. And I have ended by saying that

"matter, then, in its ultimate nature, is as absolutely incomprehensible as space and time." In the second part of the work, in chapters treating of "The Indestructibility of Matter," "The Continuity of Motion," and "The Persistence of Force," I have at some length elaborated the view that force is the ultimate component of thought into which our conceptions of external existences are resolvable. Summing up the first of these chapters, I have said, "Thus, then, by the indestructibility of matter, we really mean the indestructibility of the *force* with which matter affects us." At the close of the second of these chapters I have argued that "the continuity of motion, as well as the indestructibility of matter, is really known to us in terms of *force*; . . . that which defies suppression in thought, is really the force which the motion indicates." And then in the third chapter, having shown how the truths that matter is indestructible and motion continuous, can be known to us only as corollaries from the truth that force is persistent —that force is that "out of which our conceptions of matter and motion are built"—I have gone on to say that, "by the persistence of force, we really mean the persistence of some power which transcends our knowledge and conception." Throughout all which arguments the implication is that I hold matter and motion to be conditioned manifestations of this unknown power. Being aware of the perversity of critics, I have, in the "Summary and Conclusion," again endeavored to bar out misinterpretation. Here is one of the sentences it contains: "Over and over again it has been shown in various ways that the deepest truths we can reach are simply statements of the widest uniformities in our experience of the relations of matter, motion, and force; and that matter, motion, and force are but symbols of the unknown reality. A power of which the nature remains for ever inconceivable, and to which no limits in time or space can be imagined, works in us certain effects. These effects have certain likenesses of kind, the most general of which we class together under the names of matter, motion, and force." In which sentences it is distinctly stated that I have throughout regarded matter, under the form present to consciousness, as a *symbol*—a certain conditioned *effect* wrought in us by the unknown power; and I have gone on to say that "the interpretation of all phenomena in terms of matter, motion, and force is nothing more than the reduction of our complex symbols of thought to the simplest symbols; and when the equation has been brought to its lowest terms the symbols remain symbols still."

It will scarcely be believed, and yet it is true, that notwithstanding all this Mr. Guthrie ascribes to me the vulgar conceptions of matter and motion; argues as though I really think they are in themselves what they seem to our consciousness; and proceeds to criticise my views on this assumption. He ignores the conspicuous fact that matter and motion are both regarded by me as modes of manifestation of force, and that force, as we are conscious of it when by our own efforts

we produce changes, is the correlative of that universal power which transcends consciousness. And then he ends the criticisms forming the second part of his work by saying, "If this is not materialistic I do not know what is." He does not do this by inadvertence, though there would be little excuse even then; but he does it deliberately and with his eyes open. His next chapter begins:

"It will have been observed that in the preceding part of this criticism I have employed the term 'matter in motion,' and have avoided the use of the word 'force,' although it appears so prominently in the pages of Mr. Spencer's work. This has not been accidental, but by design, indicating as it does one of my main criticisms of Mr. Spencer.

"I can logically take up one of two positions. The first recognizes matter, whose properties are merely those of extension, which are capable of being described in terms of geometry and arithmetic. I can also recognize as the sole active properties of matter its modes and rates of motion—the motion, that is to say, of ultimate units, atoms, molecules, or masses, also capable of measurement.

"The second position recognizes matter and its activity or activities—matter as endowed with force or forces."

Thus it will be observed that having avowedly dealt with matter and motion as modes of force, I am "by design" criticised as though I had not so dealt with them. Having distinctly said what I mean by matter and motion, I am practically told that I shall not mean that, but shall mean what Mr. Guthrie means; and shall be dealt with accordingly. And then, further, it will be observed that of the two positions which Mr. Guthrie lays down as possible, and proceeds to argue upon as alternatives, one or other of which I must accept, both speak of matter and units of matter as though actually existing under the forms thought by us; and the last, speaking of "matter as endowed with force or forces," implies that whether in mass or in units, matter is a space-occupying something which is in the one case inert and in the other case made active by force with which it is "endowed"—force which is added to the inert something. Spite of all the pains I have taken to show that I regard matter as *itself* a localized manifestation of force—spite of all the evidence that our idea of a unit of matter, or atom, is regarded by me simply as a symbol which the form of our thought obliges us to use, but which we can not suppose answers to the reality without committing ourselves to alternative impossibilities of thought, I am debited with the belief that matter actually consists "of space-occupying units, having shape and measurement." Though I have repeatedly made it clear that our ideas of matter, motion, and force are but the $x$, $y$, and $z$ with which we work our equations, and formulate the various relations among phenomena in such way as to express their order in terms of $x$, $y$, and $z$—though I have shown that the realities for which $x$, $y$, and $z$ stand can not be conceived by us as

actually existing thus or thus without committing ourselves to alternative absurdities; yet questions are put implying that I must hold one or other hypothesis concerning these actual existences, and I am supposed to be involved in all the difficulties which arise.

Another work devoted to the refutation of my views is that of Professor Birks—"Modern Physical Fatalism and the Doctrine of Evolution, including an Examination of Mr. H. Spencer's First Principles." Having dealt with the work of Mr. Guthrie, I can not pass by that of Professor Birks without raising the suspicion that I find some difficulty in dealing with it. Indeed, I do find a difficulty—a difficulty illustrated by that found in disentangling a skein of silk which has been pulled about by a child for half an hour. And just as the patience of a bystander would fail were he asked to look on until, by unraveling the tangled skein, its continuity was proved, so would the reader's attention be exhausted before I had rectified one tenth part of the meshes and knots into which Professor Birks has twisted my statements.

Abundant warrant for this assertion is furnished by the very first paragraph succeeding the one in which Professor Birks announces that he is about to take "First Principles" as representative of the "fatalistic theory." In this paragraph he represents me as asserting that ultimate religious ideas are "incapable of being conceived." He further says that ultimate scientific ideas are by me "pronounced equally inconceivable." Now, any clear-headed reader who accepted Professor Birks's version of my views would be led to debit me with the absurdity of saying that certain things which are put together in consciousness (ideas) can not be put together in consciousness (conceived). To conceive is to frame in thought; and as every idea is framed in thought, it is nonsense to say of any idea that it can not be conceived—nonsense which I have nowhere uttered. My statement is that "ultimate scientific ideas, then, are all representative of realities that can not be comprehended"; and the like is alleged of ultimate religious ideas. The things which I say can not be comprehended or conceived, are not the *ideas*, but the *realities* beyond consciousness for which the ideas in consciousness stand. In Professor Birks's statement, however, inconceivableness of the realities is transformed into inconceivableness of the answering ideas! Further, at the end of this first paragraph which deals with me, I am represented as teaching that religion "is equivalent to nescience or ignorance alone." This statement is as far removed from the truth as the others. I have argued at considerable length, and in such various ways that I thought it impossible to misunderstand me, that though the Power universally manifest to us through phenomena, alike in the surrounding world and in ourselves—the Power "in which we live and move and have our being"—is, and must ever remain, inscrutable; yet that the existence of this inscru-

table Power is the most certain of all truths. I have contended that while, to the intellectual consciousness, this Power, though unknowable in nature, must be ever present as existing, it must be, to the emotional consciousness, an object to the sentiment we call religious; since, in substance if not in form, it answers to the creating and sustaining Power toward which the religious sentiment is in other cases drawn out. Yet though in the most emphatic way I have represented this unknown and unknowable Power as the object-matter of religion, Professor Birks represents me as saying that the unknowableness of it is the object-matter of religion! Though I hold that an ultimate being, known with absolute certainty as existing, but of whose nature we are in ignorance, is the sphere for religious feeling, he says I hold that the ignorance alone is the sphere for religious feeling!

When in the first sixteen lines specifically treating of my views these three cases occur, it may be imagined what an intricate plexus of misrepresentations, misunderstandings, and perversions fills the three hundred and odd pages forming the volume. Especially may it be anticipated that the metaphysical discussions, occupying five chapters, are so confused that it is next to impossible to deal with them. I must limit myself to giving a sample or two from this part of the work: one of them illustrating Professor Birks's critical fairness, and the other his philosophic capacity.

In his chapter on "The Reality of Matter," he says (page 111), "The sense of reality in things around us, Mr. Spencer has truly said, is one which no metaphysical criticisms can shake in the least"; and the rest of the paragraph is devoted to enlarging upon this proposition. The next paragraph begins—"'Permanent possibilities of sensation' is merely an ingenious phrase, to disguise and conceal a self-contradiction": sundry antagonistic criticisms upon this phrase being appended. And then the opening words of the paragraph which succeeds are quoted from "First Principles." Now, since the refutation of my views is the aim of the work; and since both the preceding and succeeding passages specifically refer to my work; and since no other name is mentioned—every reader, not otherwise better instructed, will conclude that as a matter of course the phrase "permanent possibilities of sensation" is mine; and that the criticisms upon it tell against me. Even were there evidence that this phrase, "permanent possibilities of sensation," expressed, or harmonized with, a doctrine entertained by me; yet, as the phrase is not mine, the quoting it as mine would have been a literary misdemeanor. What, then, must be said of it when, instead of standing for any view of mine, it stands for an opposite view? Mr. Mill's expression, quoted by Professor Birks as though it were my expression, belongs to a theory of knowledge entirely at variance with that set forth and everywhere implied in "First Principles"; and a theory which, where the occasion was fit, I have persistently combated (see "Principles of Psychology,"

Part VII, "General Analysis"). And yet Professor Birks tacitly makes me responsible for the incongruities which result from uniting this theory with the opposed theory.

From this sample of critical truthfulness let us pass now to a sample of critical acumen.

In arguing against Hamilton and Mansell in § 26, I have said: "It is rigorously impossible to conceive that our knowledge is a knowledge of appearances only, without at the same time conceiving a reality of which they are appearances; for appearance without reality is unthinkable." On page 121 of his work, Professor Birks, quoting the last five words of this sentence, continues, "This is true, when once the conception of distance has been gained by actual experience." And he then proceeds to comment upon visual impressions, illusive and other. Again, on page 135, when criticising my argument concerning the indestructibility of matter, Professor Birks says: "Matter, as knowable, is declared to be not the unseen reality, but the sensible appearances, or phenomenal matter alone. Phenomenal matter, it appears from daily and hourly experience, appears and disappears, perishes and is new-created continually. . . . The cloud vanishes, the star sets, or a mist blots it out, the drop evaporates, the ship melts into the yeast of waves, the candle is burned away and comes to an end. The substance may last in another form, but the phenomenon or appearance is gone. . . . Thus, by the theory, of Matter, the Noumenon, we know nothing, and therefore can not know that it is indestructible. Of Matter, the Phenomenon, we may know much. And one main thing we know of it, proved by hourly experience, is that it both may be and continually is destroyed. For an appearance is destroyed and perishes, when it ceases to appear." In which sentences, as in all accompanying sentences covering several pages, the implication is that Professor Birks identifies appearance in the philosophical sense with appearance in the popular sense! Everywhere his expressions and arguments make manifest the fact that Professor Birks thinks the meaning of phenomenon in metaphysical discussion is no wider than that implied by its derivation—something visible! Sounds, smells, tastes are in his view not phenomena; nor are touches, pressures, tensions. And hence it results that since when a pound of salt is dissolved in water it ceases to be visible, its existence, phenomenally considered, ends: its continued power of affecting our senses by its weight, to the same extent as before the solution, not being considered as a phenomenal manifestation of its existence!

In § 46, when commenting on the mental confusion which metaphysical discussions often produce, I have ascribed this in part to the misleading connotations of the words "appearance" and "phenomenon"; and after illustrating this have said: "So that the implication of uncertainty has infected the very word *appearance*. Hence, philosophy, by giving it an extended meaning, leads us to think of all

our senses as deceiving us in the same way that the eyes do; and so makes us feel ourselves floating in a world of phantasms. Had *phenomenon* and *appearance* no such misleading associations, little, if any, of this mental confusion would result. Or did we in place of them use the term *effect*, which is equally applicable to all impressions produced on consciousness through any of the senses, and which carries with it in thought the necessary correlative *cause*, with which it is equally real, we should be in little danger of falling into the insanities of idealism." This caution was intended for the general reader. That it might be needed by one who should undertake to deal with the work critically never occurred to me. Not only, however, does it seem that Professor Birks (who quotes the last three words of the paragraph) needs such a caution, but it further seems that the caution is thrown away upon him. For just those misinterpretations of the words above pointed out, are the misinterpretations he makes. After this I shall, I think, be absolved from examining further his metaphysical criticisms.

Of his criticisms upon various of the physical doctrines which this work contains, I will notice two only—the one because I wish to repudiate a view which, spite of abundant evidence to the contrary, he ascribes to me; and the other, because, based as his statement is on a fact which he misinterprets, it is desirable to give the right interpretation of it. On page 188, Professor Birks says: "The essence of the doctrine held by Mr. Grove, Dr. Tyndall, and Mr. Spencer, and which the last has made the foundation of his whole theory of physical fatalism, is that there is, every moment, an unchanging total of force, which never varies in amount, while it incessantly changes its form. The force, then, which persists, must be a present existence. But potential energy is nothing of the kind. It is the sum of trillions of trillions of future possibilities of force, ranging through trillions of trillions of different future intervals of time." Now, the tacit implication here is, that I accept the doctrine of potential energy. The men of science named, with many others who might be added, hold that the total quantity of force remains constant. Against these it is urged that energy in becoming potential ceases to exist; and that, therefore, the doctrine is untrue. And being represented as holding this doctrine in common with them, I am said to have based my general fabric of conclusions upon a fallacy. In the first place, I have to ask on what authority Professor Birks assumes that I hold the doctrine of potential energy in the way in which it is held by those named? And in the second place, I have to ask how it happens that Professor Birks, elaborately criticising my views step by step, deliberately ignores the passages in which I have repudiated this doctrine? In the chapter on "The Continuity of Motion" I have, at considerable length, given reasons for regarding the conception of potential energy as an illegitimate one, and have distinctly stated that I am at issue with scientific

friends on the matter. Devoting, as Professor Birks does, his chapter entitled "The Transformation of Force and Motion," to the incongruities which result when the doctrine of the persistence of force is joined with the doctrine of potential energy, as commonly received, it was doubtless convenient to assume, spite of the direct evidence to the contrary, that I accept this doctrine, and am implicated in all the consequences. But there can be but one opinion respecting the honesty of making the assumption. Let me add that my rejection of this doctrine is not without other warrant than my own. Since the issue of the last edition of this work, containing the passages I have referred to, Mr. James Croll, no mean authority as a mathematician and physicist, has published in the "Philosophical Magazine" for October, 1876, page 241, a paper in which he shows, I think conclusively, that the commonly accepted view of potential energy can not be sustained, but that energy invariably remains actual. I learn from him that he had in 1867 indicated briefly this same view.

The remaining case, above adverted to as calling for comment, concerns my motive for suppressing a certain passage in the chapter on "Ultimate Scientific Ideas," and substituting another passage. Before proceeding to state the reasons for this substitution, and to disprove the inferences which Professor Birks draws from it, I may remark that it is usual in literary criticism to judge an author by the latest expression of his views. It is commonly thought nothing but fair that if he has made an error (I say this hypothetically, for in this case I have no error to acknowledge), he should be allowed the benefit of any correction he makes. Professor Birks, however, apparently thinks that, moved by the high motive of "doing God service," he is warranted in taking the opposite course—perhaps thinks, indeed, that he would fail of his duty did any regard for generous dealing prevent him from making a point against an opponent of his creed.

But now, saying no more about the ethics of criticism, I pass to the substantial question. In the first place, I have to point out that in the passage suppressed I have not said that which Professor Birks alleges. He represents me as asserting that "gravitation is a necessary result of the laws of space" (p. 227). I have asserted no such thing. He says, "There can be no *a priori* necessity that every particle should act on every other at all at every distance" (p. 222). I have nowhere said, or even hinted, that there is any such *a priori* necessity. The notion that "gravitation results by a fatal necessity from the laws of space," which he ascribes to me (p. 229), is one which I should repudiate as utterly absurd, and one which is not in the remotest way implied by anything I have said. What I have said is that "light, heat, gravitation, and all central forces, vary inversely as the squares of the distances," and that "this law is not simply an empirical one, but one deducible mathematically from the relations of space." Now, what is here said to be "deducible mathematically from the rela-

tions of space"? Not a thing, or a force, but a *law*. What is the law here said to be knowable *a priori?* The *law of variation* of any or every central force. And what is alone included in the assertion of this *a priori* law? Simply this, that *given* a central force, and such is the law according to which it will vary. Nothing is alleged respecting the existence of any central force. Does Professor Birks contend that if I say that light, proceeding from a center, necessarily varies inversely as the square of the distance, I thereby say that the existence of light itself is known *a priori* as a result of space relations? When I assert that of the heat radiating in all directions from a point, the quantity falling on a given surface necessarily decreases as the square of the distance increases, do I thereby assert the necessary existence of the heat which conforms to this law? Why then do I, in asserting that the *law of variation* of gravity "results by a fatal necessity from the laws of space" simultaneously assert that "*gravitation* results by a fatal necessity from the laws of space"? Professor Birks, however, because I assert the first says I assert the second. My proposition, Central forces vary inversely as the squares of the distances, he actually transforms into the proposition, There is a cosmical force which varies inversely as the squares of the distances; and debiting me with the last as identical with the first, proceeds, after his manner, to debit me with various resulting absurdities.

Having thus shown that the passage in question contains no such statement as that which Professor Birks says it contains, I go on to show that I have not removed this passage because I have abandoned the belief it embodies. Clear proof is at hand. If Professor Birks will turn to the "Replies to Criticisms" contained in the third volume of my "Essays: Scientific, Political, and Speculative" (pp. 334–337), he will find that I have there defended the above proposition against a previous attack; and assigning, as I have done, justification for it, I have shown no sign of relinquishing it. Why, then, Professor Birks will ask, did I make the change in question? Had his mental attitude been other than it is, he might readily have divined the reason. Knowing, as he seemingly does, that this doctrine which he criticises had been already criticised in a similar manner (for otherwise he would scarcely have discovered the change I have made), he might have seen clearly enough that the passage was suppressed simply to deprive opponents of the opportunity of evading the general argument of the chapter by opening a side issue on a point not essential to its argument.

The chapter has for its subject, certain incapacities of the human mind—a subject, by the way, on which theologians are never tired of enlarging when it suits their own purpose, but on which an antagonist may not enlarge without exciting their anger. Various examples of these incapacities are given, to justify and enforce the conclusion drawn. Among these was originally included the example in ques-

tion. Misrepresenting it as Professor Birks misrepresents it, another writer had before him similarly based on his misrepresentation sundry animadversions. Though still regarding the statement I had actually made (not the one ascribed to me) as valid, I concluded that it would be best to remove the stumbling-block out of the way of future readers, and therefore decided to replace the illustration by another. The rest of the chapter remains exactly as it was, and its argument is not in the remotest degree affected by the substitution. Nevertheless, Professor Birks, wrongly describing the nature of the illustration, and wrongly attributing the removal of the illustration to change in my belief, also wrongly conveys the impression that the doctrine which the illustration contained had some vital connection with the general argument of the chapter and with the doctrine of the work; and by conveying this impression calls forth exultation from religious periodicals.

Were I to deal with Professor Birks's book page by page, a much larger book than his would be required to expose his misstatements, perversions, confusions. The above examples must suffice. I will add only that in one belief of his I cordially agree with him. At the close of his preface he says, "I think that those who take the pains to read my strictures, and compare them with the statements of the work to which they are a reply, will find the effort repaid by a clearer apprehension of the topics in debate." And I venture to join with this the expression of my belief that if readers follow Professor Birks's tacit suggestion, "a clearer apprehension of the topics in debate" will not result from acceptance of his criticisms.

## LUBBOCK ON INSECT CONSERVATISM.

SIR JOHN LUBBOCK will certainly earn the praise of accumulating more facts upon which we may found reasonable inferences as to the intellectual character of the ant, than all his acute predecessors in the same field put together. And his latest published observations on the subject, communicated to the Linnæan Society, and printed in their "Transactions," contain some of his most interesting results. These results we should describe generally as showing that the ants display, first, a preternaturally keen sense of consanguinity; next, a good deal of that narrow conservatism which is so often the result of too much belief in the family and too little receptivity for the ideas of the external world; in the third place, a thorough distrust of revolution, so that they are almost equally afraid of establishing a new dynasty and of destroying an old one; and, finally, a good deal of the skepticism which narrow conservatism inevitably engenders toward all

suggestions not fitting easily into the established grooves. The ant, it is evident, does not, like Lord Beaconsfield, believe mainly in *race*, but, on the contrary, like the English squire, "acred up to his lips, consoled up to his chin," believes chiefly in family, and, we must add, has shown much more amazing instincts than any English squire in discriminating the progeny of one group of families from the progeny of another. That a strange ant, though of the same species, put into any nest, will be at once attacked and killed, Sir John Lubbock has proved again and again. Like the English rustic who, on assuring himself that a man is a stranger to the district, immediately proposes to "'eave 'alf a brick at him," the ants pay no regard to species at all, if they find an ant who can not trace his descent to their own nest intruding upon it. They make a principle of hostility to aliens, drawing no distinction between aliens of their own species and aliens of another species. But the remarkable thing appears to be their special instinct for identifying the descendants of their own tribe. Sir John Lubbock separated into two parts, in February, 1879, a nest of ants which contained two queens, giving about the same number of ants and one queen to each. In February the nest contains neither young nor eggs, so that the division was made before the earliest stage of being for the next generation began. In April both queens began to lay eggs. In July, Sir John Lubbock took a lot of pupæ from each division, and placed each lot on a separate glass, with attendants from the same division of the nest. At the end of August he took four previously marked ants from the pupæ bred in one division and put them into the second division, and one previously marked ant from the pupæ bred in the second division and put it into the first; in both cases the ants, which could never have been seen in any stage of their life by any of the ants in that division, were welcomed as friends, cleared of Sir John's paint, and accepted as members of the family. The same thing happened again and again. But whenever a stranger was introduced after the same fashion, it was immediately attacked and destroyed. This confirmed still more remarkably a series of less crucial experiments formerly made by Sir John Lubbock on the same subject. By some inscrutable sense or other, the ants, it is clear, know the descendants—at least in the first degree—of those which have once belonged to their own nest, even though they were neither born nor thought of when their parents left the nest. So much for the profound instinct of consanguinity in the ant, as well as for the unconquerable hostility they show to those ants who are not connected with them, within recognizable degrees at least, by blood.

But now as to the intense political conservatism which this bigoted sort of family feeling produces. Sir John Lubbock has discovered, it appears, that once let an ants' nest get accustomed to living without a queen—once let it organize democratic institutions—and nothing will induce it to admit a queen for the future. Queens introduced into

queenless nests were always ruthlessly killed, even though in one case Sir John exhibited the queen for three days to the ant-democracy in a wire cage which protected her from them, in order to accustom them to the sight of royalty. The moment the protecting wire was removed, the queen was attacked and slain, just as if she had been an ordinary alien. Sir John, however, was occasionally able, by the help of a little intrigue—of the Marshal MacMahon kind, but more successful—to obtain a throne for a wandering queen. The way he managed was this: He took a few ants from their nest, and put them, in that disorganized state, with a strange queen. The ants were then in a timorous and diffident mood. They had no fixed institutions to fall back upon. They felt wanderers in the world. And, feeling this, they did not attack the queen, but rather regarded her as the nucleus of a possible organization. By thus gradually adding a few ants at a time to a disorganized mob which had accepted the queen as the starting-point for a new polity, "I succeeded," says Sir John Lubbock, "in securing the throne for her." But this success speaks as much for the conservatism of the ants as the former unanimous rejection of the queen by an organized community. They repudiated a queen when they knew that their institutions were in working order without her. They accepted her, when they felt at sea and in peril of anarchy, as the germ of a new system. It was a timid conservatism which dictated their policy in each case. In the former, they rejected with horror the prospect of a change of constitution; in the latter, they accepted, not, perhaps, without eagerness, the prospect of a more rapid political development than, without any ready-made leader, they could have counted upon. For the ants, then, the throne was, as M. Thiers said of a republic, under dissimilar circumstances, the constitution "which divided them least."

And it is to be inferred, we think, that the languid skepticism which is one of the commonest causes or effects—it is difficult to say which—of that intense timidity which is so often connected with conservatism, affects these wonderful little creatures also. Sir John shows us most satisfactorily that the ants understand each other—that when an ant goes back from a bit of food which she is unable by her own strength to stir, she can and does communicate in some way to her fellow-ants the need of help. They clearly understand her message, and they prepare to assist her; but they have, it appears, no real confidence in her information. What they see with their own eyes fills them with the utmost eagerness, but what they learn from others they do not more than half believe. They usually go with the messenger, but they go without any real *élan*, without any of that earnestness which they display after getting personal experience of the existence of the store of food. After that they are all urgency. After that they outrun their fellows, and can not reach the store of provisions too soon. But on the hearing of the ear they act with the utmost languor.

They follow, but so slowly that they never keep up with their eager guide, soon drop behind, and generally give up the expedition, as one beyond their courage or strength, or at least too much for their half-faith. Let us hear Sir John's curious delineation of the sort of authority which one ant's information appears to carry to his fellow-ants :

"I selected a specimen of *Atta testaceo-pilosa*, belonging to a nest which I had brought back with me from Algeria. She was out hunting about six feet from home, and I placed before her a large dead blue-bottle fly, which she at once began to drag to the nest. I then pinned the fly to a piece of cork, in a small box, so that no ant could see the fly until she had climbed up the side of the box. The ant struggled, of course in vain, to move the fly. She pulled first in one direction and then in another, but, finding her efforts fruitless, she at length started off back to the nest empty-handed. At this time there were no ants coming out of the nest. Probably there were some few others out hunting, but for at least a quarter of an hour no ant had left the nest. My ant entered the nest, but did not remain there ; in less than a minute she emerged, accompanied by seven friends. I never saw so many come out of that nest together before. In her excitement the first ant soon distanced her companions, who took the matter with much *sang-froid*, and had all the appearance of having come out reluctantly, or as if they had been asleep and were only half awake. The first ant ran on ahead, going straight to the fly. The others followed slowly and with many meanderings ; so slowly, indeed, that for twenty minutes the first ant was alone at the fly, trying in every way to move it. Finding this still impossible, she again returned to the nest, not chancing to meet any of her friends by the way. Again she emerged in less than a minute with eight friends, and hurried on to the fly. They were even less energetic than the first party ; and, when they found they had lost sight of their guide, they one and all returned to the nest. In the mean time, several of the first detachment had found the fly, and one of them succeeded in detaching a leg, with which she returned in triumph to the nest, coming out again directly with four or five companions. These latter, with one exception, soon gave up the chase and returned to the nest. I do not think so much of this last case, because, as the ant carried in a substantial piece of booty in the shape of the fly's leg, it is not surprising that her friends should some of them accompany her on her return; but surely the other two cases indicate a distinct power of communication. Lest, however, it should be supposed that the result was accidental, I determined to try it again. Accordingly, on the following day I put another large dead fly before an ant belonging to the same nest, pinning it to a piece of cork as before. After trying in vain for ten minutes to move the fly, my ant started off home. At that time I could only see two other ants of that species outside the nest. Yet in a few seconds, considerably less than a minute, she emerged with no

less than twelve friends. As in the previous case, she ran on ahead, and they followed very slowly and by no means directly, taking, in fact, nearly half an hour to reach the fly. The first ant, after vainly laboring for about a quarter of an hour to move the fly, started off again to the nest. Meeting one of her friends on the way, she talked with her a little, then continued toward the nest, but, after going about a foot, changed her mind, and returned with her friend to the fly. After some minutes, during which two or three other ants came up, one of them detached a leg, which she carried off to the nest, coming out again almost immediately with six friends, one of whom, curiously enough, seemed to lead the way, tracing it, I presume, by scent. I then removed the pin, and they carried off the fly in triumph. Again, on June 15th, another ant belonging to the same nest had found a dead spider, about the same distance from the nest. I pinned down the spider as before. The ant did all in her power to move it; but after trying for twelve minutes, she went off to the nest. For a quarter of an hour no other ant had come out, but in some seconds she came out again with ten companions. As in the preceding case, they followed very leisurely. She ran on ahead, and worked at the spider for ten minutes; when, as none of her friends had arrived to her assistance, though they were wandering about evidently in search of something, she started back home again. In three quarters of a minute after entering the nest she reappeared, this time with fifteen friends, who came on somewhat more rapidly than the preceding batch, though still but slowly. By degrees, however, they all came up, and after most persevering efforts carried off the spider piecemeal. On July 7th I tried the same experiment with a soldier of *Pheidole megacephala*. She pulled at the fly for no less than fifty minutes, after which she went to the nest and brought five friends exactly as the *Atta* had done."

Can anything be more remarkable than the extraordinary difference in the demeanor of the ants taught by personal experience, and of the ants trusting to the report of another? Obviously, the latter had a very languid belief in the statements of their friends, just enough to make them enter on the enterprise, but not enough to make them prosecute it even so far as to hasten their pace in order to keep up with their eager friend. Clearly, the ants are not very good judges of character. Their predisposition to distrust sanguine statements, like the predisposition of timid conservatives in general, is so deep, that at the first obstacle they fall away, perhaps questioning the use of tasking themselves for news that sounds so improbable as that of a treasure-trove. Sir John Lubbock even reports one case in which a slave-ant, of the Polyergus species, twice returned to her nest in search of co-operation in vain. Nothing she could say would induce her fellow-slaves to enter on a new bit of work, without better evidence of its remunerative character than a wandering fellow-servant's report gave

them. Twice she returned alone to the unequal task, reproaching bitterly, no doubt, the faithlessness of her associates.

Those who doubt our reports of the extremely timid political caution of these insect tribes will convince themselves that we are not exaggerating if they will but refer to Sir John's very interesting account of these formican Conservatives—Tories they are not, for obviously there is no blatant element in the politics of the ants. Their democracy, when they are democrats, is the democracy of the Swiss Republic, not the democracy of the Imperialists, still less the democracy of the French Revolution.—*Spectator.*

## DISTINCTIONS BETWEEN REAL AND APPARENT DEATH.

By Dr. WILLIAM FRASER.

A SATISFACTORY definition of life should express conditions involved in every phase of vital development, but never identified with any mode of inanimate existence. Transmutation represents one such fundamental distinction between animate and inanimate objects; for, although some inorganic combinations possess a degree of permutability consistent with substantial integrity, this in particular cases is always uniform in character and limited in extent. Ice, for example, may become successively changed into the liquid and gaseous state without chemical decomposition, but there is an intrinsic limit to such permutation, for under similar circumstances of pressure, at an unalterably fixed elevation of temperature, it invariably becomes resolved into simpler constituents.

There are apparently no such inherent restrictions to organic transmutations, which may be perpetuated indefinitely, under appropriate supplementary conditions, without perceptible intrinsic exhaustion. Yet organisms are never sufficiently independent to spontaneously evolve such progressive results, but require the constant accession of extrinsic energy to develop their included potentialities.

The sun is the physical source of extraneous energy for every species of vital change occurring on the earth's surface, as through the immediate agency of its rays vegetables are enabled to abstract from the surrounding medium those elements adapted to their special needs; and, although animals can not thus directly appropriate solar energy, yet they are enabled to utilize it by the assimilation of certain of these vegetable products which it has previously served to elaborate.

As all the progressive transmutations which indispensably constitute individual life are dependent on the constant incretion of material

energy, integration is also a universal concomitant of vitality, so that for practical purposes life may be provisionally defined as the continuous individual integration and differentiation of material energy.

While these two correlated processes pertain to every variety of life, the physiological expedients by which their respective activities are sustained must vary in conformity with the specific requirements of different structures. A simple unit of protoplasm effects all its vital purposes through direct interchange with its environment, without the necessity of any intermediate provision. But, in higher organisms, life is indissolubly associated with certain accessory processes, and, in these cases, though the molecular interactions on which its essential attributes immediately depend are directly imperceptible, yet it is possible to prove its existence or non-existence by sensibly demonstrating the presence or absence of these its inseparable concomitants.

Man with his powers unimpaired manifests his vitality in unmistakable terms, but conditions not incompatible with resuscitation may occur wherein all his functions are so reduced as to be directly imperceptible. In such cases, to prevent premature burial, it is important to discover some sign absolutely diagnostic of real or apparent death.

An essential characteristic of living bodies is their power of actively maintaining a degree of varying integrity of constitution in opposition to destructive influences. This requires the incorporation of extraneous materials and their conversion into definite specific structures, and always involves the immediate apposition of ingredients, as well as a reciprocal state of the parts to be nourished. Although such intimate reciprocation of living structures and nutrient materials must always exist, the means whereby it is effected varies exceedingly in different instances. In the lower order of beings it is accomplished very simply, the medium which they inhabit offering directly the requisite pabulum, which their own condition enables them to assimilate without any preparatory elaboration. In more complex organisms a definite correlation of parts is necessary to elaborate the crude materials of food, as well as to bring them into immediate relation with the various tissues.

In some simple forms vital action may be suspended indefinitely by desiccation, being restorable by moisture, and even in some higher cold-blooded animals a state of temporary negation may be induced by congelation, the vital powers returning concurrently with the absorption of heat. In man it is quite different: the animal functions may be suspended, and even some of the organic processes interrupted, without extinguishing life, but there are certain of his functions the cessation of which for a limited period must inevitably cause death.

As to their vital significance, man's functions may be classified into essential and supplemental—the former including such as can not be

discontinued beyond a brief interval without fatal consequences, the latter such as may be suspended or even destroyed without involving general dissolution. Thus, although sight is important to comfort, it may be lost without affecting vitality; the hepatic function may be vicariously performed; even the renal secretion may be suspended for a considerable period without death: but the complete cessation of any of the essential functions of circulation, innervation, or respiration must be speedily followed by such a result. By the circulatory forces, a constant flow of blood is directed to and from all the parts; by the nervous system, an alternating effect is produced on the tissue-elements, whereby at one time they assimilate, at another disintegrate; by the respiratory apparatus, certain of the resultant products are incessantly eliminated. These three complemental functions are so interdependent that the complete interruption of either necessarily leads to arrestment of all, and consequent death.

Human blood is of a highly complex nature, as through it the textures receive all the materials adequate to their continued maintenance and repair. Its chemical composition is never definite, varying in different individuals and in the same individual on different occasions. The relative uniformity, however, of some of its physical characters is indispensable to its vital efficiency. It is semi-solid, containing innumerable white and red corpuscles, the latter constituting nearly one half its mass. The absolute number of these corresponds with the degree of general vitality; their local aggregation fluctuates with varying contingencies.

This fluid is the seat of two distinct modes of motion—a sensible circulation through the heart and vessels, and a subtiler interchange with tissue-elements. Several causes conspire toward its circulatory mass-motion, the heart's action being a *sine qua non*. The molecular motions being invisible, an explanation of their *modus operandi* must be partly hypothetical. There are, however, certain associated phenomena admitting of direct observation under certain circumstances which serve to throw light on the physico-vital relations of the blood. Thus, besides its general distribution, it is subject to local variations in the total quantity of its mass, and in the relative proportion of its various constituents. As there are means of artificially exciting preternatural activity of the circulation to a recognizable extent, in parts open to observation, during the minimum degree of vitality, such a possibility affords a reliable method of infallibly deciding in any particular case as to the existence or non-existence of this vital process.

Tissues are divisible into vascular and non-vascular, according to the mode and extent of their nutritive supply. The latter, being destitute of capillaries, receive their nourishment from the neighboring vessels by endosmosis. The former are pervaded by those minute vessels, which admit red corpuscles in a lesser or greater number, ac-

cording to the degree of functional exaltation. The cutis vera being a superficial vascular tissue, the excessive accumulation of red corpuscles in its capillaries is readily perceived by the consequent floridity of surface. Such sensible reaction to direct irritation implies the concurrence of several determinate acts in the structures directly involved, as well as the coöperation of more remote parts. Thus the tissue-elements must possess a responsive power to become exalted in function, and to solicit a surplus of blood-ingredients they must also retain a continuity with the presiding nerve-center, whereby the peripheral impression may be centripetally transmitted along the afferent nerve to this point, thence reflected along the vaso-motor nerve, causing relaxation of the arteriolar muscles, enlargement of caliber, and a freer flow of blood into the part. Cardiac contractions are also necessary to propel the corpuscles into the capillaries, as the attraction of the tissue-elements for these minute bodies can act only at insensible distances.

Man's structure conceals the changes which occur within the minute blood-vessels, but some animals admit the examination of the interior processes which accompany and conduce to the external manifestations of capillary congestion. Observing the circulation in the web of the frog's foot under the microscope, fluctuations in its current are noticed independent of the heart's action. The corpuscles, perhaps flowing uniformly at first, may slacken their speed, then oscillate or even retrograde. Apply an irritant to the part, the flow soon increases, and a greater number of red corpuscles pass through in a given time; they also show a tendency to cohere as well as to adhere to the walls of the vessels, which may proceed so far as to choke up their caliber and prevent the transmission of blood. As the effect passes off, the corpuscles gradually separate, move on, and at length the circulation resumes its normal state. Such investigation explains the nature of the changes which occur in the capillaries of the human skin under artificial stimulation.

Heat, which is the most potent and available form of irritant, when applied to the skin so as to considerably elevate its temperature above the normal point, causes first an efflorescence of surface, deeper at the center and shading off gradually toward the circumference. This redness can be temporarily displaced, leaving a white impression, which disappears on removal of the pressure, the part resuming its floridity with a rapidity commensurate with the activity of the capillary circulation. By increasing the heat or prolonging its action the color becomes more distinct, till at the point of greatest intensity the cuticle becomes detached from its subjacent cutis by the gradual exudation and accumulation of a fluid which thus forms a true vesicle. A spurious vesicle may be similarly produced on the dead subject, but such is a purely physical and local effect, entirely different from the more comprehensive action and characters of the physiological process.

In *post-mortem* vesication the contents are generally gaseous from

decomposition, and even if fluid, from infiltration in an œdematous or dependent part, this is always serum, unlike the vital fibrino-albuminous solution coagulable by heat. The pathognomonic distinction, however, is the difference presented by the underlying cutis on removing the loosely adherent cuticle. This, after death, has an unalterable yellowish-white, crisp, horny appearance, in obvious contrast to the efflorescence of vital active congestion, which can be repeatedly displaced and renewed by recurrent pressure.

Although circulation is a vital necessity, the chemical products of its activity would of themselves speedily destroy life except for the concurrent exercise of the respiratory and other functions.

Tissues, such as the nervo-muscular, which perform some specific action, may be classed as active in contrast to passive, such as the osseo-fibrous, which merely subserve some mechanical office. When the ultimate particles of passive tissues are fully developed, they remain in that state for a longer or shorter period, and then gradually decay. Active tissues, during their development, appropriate a store of energy which, at maturity, they are capable of instantly expending in the manifestation of their special powers. Such exertions are inevitably attended by degradative transformations of their material elements. Cardiac movements and their associated vital coördinations involve the expenditure of nervo-muscular energy, and consequent production of simpler compounds, such as carbonic acid, the undue retention of which in the blood would cause certain death. Such a fatal contingency is prevented by the circulatory forces propelling the carbonized blood into the pulmonary capillaries, where an interchange with the oxygen of the air takes place through the intervening membrane till the vesicles become surcharged with carbonic acid, which is then expelled by the expiratory forces through the anterior openings of the air-passages, where its detention is evidence of vitality, while its utter absence under adequate tests is undeniable proof of the opposite condition. For, though certain cold-blooded animals can exhale a sufficient quantity of this product through their skin to permit a reduced vitality, in man such a cutaneous transpiration is exceedingly minute and altogether inadequate to the maintenance of life, and it may continue even after death as a merely physical property of tissue.

Innervation is blended with and controls all the vital operations, being conspicuously implicated with muscular contraction, an act primarily concerned in the various movements of respiration and circulation. The frequently-repeated transmission of intense electric currents is the most powerful stimulus of contractility, and, when such a measure fails to excite contraction in muscles essential to life, death must have occurred.

When rigidity and putrefaction are actually established, they may be accepted as infallible *post-mortem* indications. The former state arises from the muscles and other soft tissues becoming so stiffened as

to resist flexion of the joints, the muscles of the lower jaw and neck being generally first involved, those of the lower extremity last. It might possibly be confounded with stiffening from extreme cold or spasms; but frozen limbs yield a creaking noise when forcibly flexed, from breakage of the congealed moisture, and spasmodic contraction resumes its morbid position on removal of the correcting force. Not so *post-mortem* rigidity.

Putrefaction succeeds rigidity as a bluish-green tint of skin, commencing usually on the lower part of the abdomen and spreading over the body. Similar gangrenous appearances may occur during life, but, besides their more circumscribed extent, the invariable presence of a line of displaceable redness at the confines of the living tissues is a constant and characteristic distinction.

The desideratum, however, is some infallible proof of death whereby this state can at once be decided without waiting for the more tardy supervention of these positively *post-mortem* phenomena.

Neither the cadaveric aspect nor coldness and lividity of surface are constant or unequivocal signs. The cessation of the heart's action beyond five minutes is undoubted evidence, but it is impossible to acoustically determine this with absolute certainty, even when aided by the stethoscope, as the sense of hearing may be fallacious in delicate cases. Neither is the imperceptibility of the respiratory movements of the chest perfectly decisive. Conclusions from experiments on the eyes, by trying to excite the pupillary muscles by physiological agents, or by examining the fundus with the ophthalmoscope so as to observe certain changes supposed to be essentially *post-mortem*, are invalidated by the comparative unimportance of these organs to general vitality. The same uncertainty holds as to the effects produced by tightly ligaturing a limb, as there might be complete occlusion of its vessels and consequent arrest of its circulation without necessarily fatal results. The changes induced in a polished needle inserted deeply into the living tissues may be closely simulated by non-vital causes. Circumstances might also obscure the difference between the contents of vital and *post-mortem* vesication.

The possibility of absolutely deciding, in doubtful cases, as to the presence or absence of vitality depends on the possession of artificial means wherewith to sensibly demonstrate the minimum activity of each of the essentially vital processes, the utter negation of the various specific reactions under their appropriate tests being infallible evidence of death. The different available measures vary in their degree of simplicity and facility of application, but the results are all equally conclusive.

The validity of the respiratory test results from the fact that even during the most reduced state of vitality carbonic acid is perpetually generated in the system, and extricated therefrom through specially adapted air-passages, where its escape can invariably be detected by proper appliances.

Allowing a few hours to elapse after apparent death, so that an equilibrium may be established between the carbonic acid in the air-chambers and the atmospheric air, if death is real the amount of this product exhaled from the anterior opening of the air-passages will exactly correspond with that transpiring from an equal area of the skin; but, if the slightest vital action continues, the proportion thus expired in a given time will far exceed the whole cutaneous transpiration. Collecting it at its point of exit, by a suitable contrivance, into a small transparent vessel containing clear lime-water, its merest presence, in contrast to any other reagent, will change this fluid at once, on shaking, into an opaque, milky solution.

The innervation test is rendered practicable through the inseparable connection of this attribute with muscular contraction; for, even if contractility is inherent in muscle, its excitation is possible only through the incorporation of nerve-elements. As this manifestation of nervo-muscular energy can always be sensibly excited by electrification during the persistence of the feeblest vitality, the utter failure to obtain such a result in parts the activity of which is essential to life, affords conclusive evidence of vital extinction. The respiratory arrangements of the glottis present a favorable opportunity for prosecuting this special mode of experiment. At every inspiration the contractions of the associated muscles stretch and separate the vocal chords, thus, nearly doubling the area of aperture. In expiration the muscles relax, allowing the parts by their elasticity to resume their natural collapsed appearance. These changes can be observed by placing the body before a bright light, and introducing a laryngoscope well back into the pharynx, so as to bring the superior laryngeal aperture into view. After death the rima glottidis presents the elongated narrow form, from the close approximation of its chords. If, under the repeated transmission of intense electric currents, properly directed, there is no responsive contraction so as to sensibly widen the aperture, death is certain.

The circulatory test, or the attempt to excite an actively congested state of the cutaneous capillaries, is preëminently the best, as it requires only simple and easily procurable appliances, which always yield decisive results either in the living or dead subject. The application of heat and the act of cupping are both effective topical means for perceptibly arousing this preternatural activity of the cutaneous circulation, even in the most languid condition of the system compatible with vitality. The entire absence of such distinctive physiological reactions and the occurrence of merely physical alterations, under the proper use of these respective measures, is undeniable proof of death. Over the heart is the most suitable region whereon to operate, as there the skin longest retains its vital warmth; but corroborative experiments may be performed over other parts of the trunk.

Hold the flame of a candle close to (*but not in contact with*) the

skin sufficiently long to render the cuticle easily detachable from its subjacent connections: if the body is dead, the parts beneath will present a crisp, yellowish-white, horny appearance, unaffected by pressure; if alive, there will be readily perceptible a vital redness, distinguishable from all *post-mortem* discolorations by its repeated displacement and reappearance under alternating pressure by tip of the finger or otherwise. Exposing the part to a bright light, and examining it through a magnifying-glass, will render the different phenomena more evident.

Kindle a piece of paper soaked in any alcoholic liquor, put it in an ordinary drinking-glass or goblet, and invert this over a part of the cutaneous surface where all its edge will come into accurate contact with the skin: if there remains a minimum degree of vitality, a state of superficial capillary congestion will be induced, with its unmistakably recurrent characters; whereas the absolute inability to excite such vital reaction in any part of the trunk's surface, and the production of solely physical effects by such potent agencies, are infallible evidence that all vital correlations are irreparably destroyed.

## SKETCH OF GENERAL ALBERT J. MYER.

GENERAL ALBERT J. MYER, extensively known as a meteorologist and the organizer of the United States and International Storm-Signal Service, was born at Newburgh-upon-Hudson, on the 20th of September, 1828. While still very young, his father removed to Buffalo. A maiden aunt took charge of the boy's education, and he early became a telegraph operator. Later, he went to school, and when sufficiently advanced entered Hobart College, Geneva. He graduated in 1847, and, having decided to study medicine, he went through the Buffalo Medical College, and obtained his degree of M. D. in 1851.

A predilection for military life impelled him to seek a field of usefulness for his surgical talents in the army, where he obtained a commission. He was ordered out upon the Plains, and it is said that one day, seeing some Comanche Indians waving their lances, the idea struck him that such motions might be utilized for army-signals, similar to those in use in the navy. The subject soon occupied a great deal of his attention, and, the more he thought about it, the more interesting it became to him, until finally he had invented an ingenious code of signals. The doctor's transformation into an inventor was noised abroad upon his return to the East, and the authorities, becoming interested in his idea, appointed a Signal Corps and placed him in command of it, and from 1858 to 1860 he was engaged in special duty, perfecting his system and educating his eighty-odd men in its use. In July, 1860, he was commissioned major, and made chief signal-officer

of the army. During the remainder of this year and until May, 1861, he was ordered to New Mexico and the Rocky Mountains by Secretary Floyd, for the purpose of giving his corps an opportunity to have actual practice in the field. On the breaking out of the war, Major Myer identified himself with the Union army. One of his lieutenants went over to the other side and succeeded in creating no little confusion, for with him he took a knowledge of the signal-service system, and it was not long before each army was able to read the signals of the other, so that constant changes in the key became necessary. He next served on General Butler's staff, at Fortress Monroe, and was General McClellan's chief signal-officer during the entire Peninsular campaign. In November, 1862, he took charge of the Signal-Office at Washington. Here he performed service which compelled recognition and remuneration at the hands of the Government, however unwillingly tendered, and he was brevetted as lieutenant-colonel for services at Hanover Court-House, colonel for services at Malvern Hill, and brigadier-general for "distinguished services in organizing, instructing, and commanding the Signal Corps of the army, and for its especial service October 5, 1864," when, by timely signals, were saved the post and garrison of Allatoona, Georgia.

It is said that General Myer was a strict disciplinarian, and exacting to the degree of intolerance. He had indomitable firmness, and it is possible that these traits of character may have been the causes why the overbearing Secretary of War, Mr. Stanton, took a dislike to him. But, whatever the causes, the Secretary's hatred took a violent form. When Myer was with Farragut before Mobile, he received an order, signed by Stanton, informing him that he was dropped out of the army on the ground that his appointment to the colonelcy had not been confirmed. Myer then came on to Washington, took a house, appealed to the Senators and Congressmen, and fought the matter out till he was reëstablished. At the close of the war Colonel Myer began to turn his attention in the direction of meteorology, and to connect that science with the art of army signaling. The Smithsonian Institution had entered upon a system of taking weather observations in different parts of the country, and Colonel Myer began to work upon this basis, and more completely to elaborate a method of forecasting meteorological probabilities.

"In 1868 General Meyer published a 'Manual of Signals for the United States Army and Navy,' and about this time it was that his field of labor began to broaden and tend upward. By virtue of an act of Congress, approved February 9, 1870, he was charged with the special duties of observing and giving notice by telegraph and signals of the approach and force of storms on the Northern lakes and the seacoast, at military posts in the interior, and other points in the States and Territories. He reorganized the meteorological division of the Signal-Office in June, 1871. By an act approved March 3, 1873, he

was placed in charge of special duties of telegraphy, etc., being authorized to establish signal-stations at lighthouses and life-saving stations wherever they might be convenient to his purposes. The training school at Fort Whipple, the signal-service drill, and the strict discipline of the weather corps, were all due to General Meyer's directing mind.

"From national observations it was quite in the natural order of things that General Myer's work should expand to international dimensions. The success of the United States Signal-Service Bureau excited the greatest interest abroad, and similar institutions were inaugurated in several of the European countries. Long before, General Myer had conceived the bold idea of a system of simultaneous observations in all parts of the Northern Hemisphere, and as soon as he could do so he pushed the matter onward, until in September, 1873, an International Congress was convened in Vienna, and he was sent there as the delegate from the United States. To this Congress General Myer proposed that 'it is desirable, with a view to their exchange, that at least one uniform observation, of such character as to be suited for the preparation of synoptic charts, be taken and recorded daily and simultaneously at as many stations as practicable throughout the world.' This proposition was unanimously adopted, and, as the delegates were virtually empowered to speak for their several countries, this vote assured the existence of the international system. From its very inception this system has proved a wonderful success, and now the following countries are taking simultaneous observations and exchanging them: Algiers, Australasia, Austria, Belgium, Central America, China, Denmark, France, Germany, Great Britain, Greece, Greenland, Iceland, India, Italy, Japan, Mexico, Morocco, the Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, Tunis, Turkey, British North America, the United States, the Azores, Malta, Mauritius, the Sandwich Islands, South Africa, South America, and the West Indies.

"On the 1st of July, 1875, General Myer began to issue from the Army-Office at Washington the daily printed bulletin. July 1, 1878, the same office began to publish its daily international weather-map, which added to General Myer's triumphs. He also instituted a system of observations in ocean meteorology, simultaneous with the international observations. These have proved of immense value, and at present nearly a hundred observers are engaged therein. Thus the work has gone forward, constantly extending, constantly progressing in accuracy.

"General Myer paid a second visit to Europe last year, ostensibly for rest. At the request of the Italian Government, he gave valuable information concerning the system, and instead of a pleasure-trip this turned out a laborious one, and finally at Venice General Myer was prostrated by the trouble which eventually has caused his death.

"Like so many other men who have won eminent position through

their own efforts, General Myer was a victim of overwork. His field of labor was an ever-widening one, and his ambitious brain knew no discretion in the matter of rest, but pushed him onward beyond his powers of physical endurance. Once before, his ceaseless industry laid him low—at a time, too, by a curious yet characteristic chance, when he was supposed to be recuperating his energies in a foreign trip. In spite of this warning, which was certainly severe enough to be heeded, he refused to leave Washington this summer, and obtain the relaxation he so much needed, but kept at his post until he became so ill that he could not sign his name. Then he was obliged to leave at a time when, as it afterward proved, he had waited too long. He was brought to Buffalo, but instead of going to his beautiful summer home at Lake View, he took apartments in the Palace Hotel, Dr. Rochester, his family physician, taking charge of his case. His trouble was a painful complication of heart and kidney troubles, and, his blood becoming poisoned by the latter disease, he became delirious. In spite of the careful treatment and perfect nursing which he received he sank slowly and died, August 24th, at the early age of fifty-two, leaving a wife and six children.

"Although dying thus in the very height of his usefulness, and when he could ill be spared from his great work, General Myer lived to see his idea of an international signal-weather system in successful operation, and already sanctioned and supported by the leading nations of the Northern Hemisphere. His great idea has passed its experimental stage, and his friends have the satisfaction of knowing that competent and enthusiastic men will carry it forward to its fullest fruition. His legacy is a grand one, comprising an honest name, an heroic record, a stainless reputation both as soldier and citizen, the honor of an unpatented invention and application of telegraphy which materially helped to save the Union, and the glory of having originated one of the grandest ideas of the century—an idea the practical application of which has already saved many lives, and which is destined when more perfectly developed to work a revolution in the science of meteorology, and to banish, in part at least, that great cause of terrestrial waste—meteorological uncertainty.

"In appearance 'Old Probabilities' was a fine-looking, soldierly appearing man, with high forehead, firm mouth, and earnest, thoughtful eyes. He wore a short-cropped, full beard, and an abundant head of hair. His physiognomy indicated great decision of character and executive ability, and these signals from Nature's code were fully confirmed in his character and life."

We are indebted for the foregoing particulars of General Myer's career to an admirable sketch in the Buffalo "Daily Courier" of August 25th.

# EDITOR'S TABLE.

*THE NATIONAL ACADEMY OF SCIENCES.*

THIS body held its November session in New York, and its meetings at Columbia College. In the absence of President William B. Rogers, Vice-President O. C. Marsh filled his chair. The proceedings were in a high degree interesting. It is commonly supposed that the disquisitions of this body belong to depths of profundity that are wholly unapproachable by ordinarily endowed mortals, but this is a quite erroneous view. There are often, to be sure, technical and mathematical papers intelligible only to those proficient in these subjects; but the principal topics considered at the recent meeting were not only of general interest, but they were so treated that well-instructed people could appreciate and enjoy them. The Academy, however, never bids for a crowd, and if there should be an influx of outsiders it would be immediately inferred that there is something wrong in the working of the association. Of the hundred members, thirty or forty usually get together at the meetings and devote themselves to reporting the results of research, and to the discussion of views presented. There are set papers, of course, but exposition is largely extemporaneous, and accompanied with blackboard and other illustrations.

The newspapers have given to the public notices of the main results of the late meeting, all of which will be more fully published in the "Transactions" of the Academy, or in the scientific periodicals. Among the novel and striking things brought forward was a new method of chemical analysis, by Dr. Wolcott Gibbs; Professor Rood's experiments in perfecting the vacuum; Professor Langley's researches into the distribution of heat in the spectrum, and his new method of measuring infinitesimal amounts of heat; Professor Henry Draper's photographs of the Orion nebula; and Professor Marsh's account of a fossil animal with an extra brain at the other end of the spinal column. The progress of the electric light was also critically discussed, and various other important subjects were duly considered. In short, if our friends the Academicians will pardon us, their meeting was a "complete success."

*THE STUDY OF GREEK AT CAMBRIDGE.*

WE drew attention, a year or two ago, to a movement in England, led by several head-masters of the public schools and other eminent gentlemen interested in education, to secure a relaxation in the university requirements regarding the study of Latin and Greek. The study of Greek was compulsory, and insisted upon as if it were the sole condition of turning out an educated man. A petition was sent to the authorities of Cambridge, asking that it be omitted if the student desired to take in its place a modern language. It was remarked that students entering the university "may be the peers of Airy and Adams in pure mathematics, of Tyndall and Huxley in natural science, of a Whewell and a Hamilton in moral science, but they must be able to read a play of Euripides and the Greek Testament, or Cambridge will not have them among its graduates." This state of things was such as to provoke decided protest on the part of liberal-minded men, and hence the public controversy upon the subject, and the petition that forced the issue upon the Cambridge authorities. A late number of the "Lancet" reports

progress on the question in the following paragraph: "A discussion took place in the Arts Schools at Cambridge on Tuesday, October 26th, on the report of an influential syndicate, which had been appointed to consider a memorial sent by schoolmasters and teachers, including the head-masters of Eaton, Winchester, Westminster, St. Paul's, Harrow, and Rugby—Matthew Arnold, C. Darwin, Sir J. Hooker, Professor Huxley, Professor Tyndall, Dr. Vaughan, and the Bishops of Exeter and Winchester. The memorial stated that 'the present regulations, according to which a knowledge of Greek is required from all candidates for the Previous Examination at Cambridge, have the effect of excluding a large and increasing number of able and deserving students from the benefits of university education,' and it respectfully prayed that the university would be pleased to take into consideration some means whereby candidates for an honor degree may be relieved from the obligation of passing an examination in Greek. After much deliberation and inquiry, the syndicate reported—1. In favor of the relaxation of the requirements of Greek in some cases; 2. That the relaxation should be restricted to candidates for honors; 3. That a knowledge of French and German should be accepted as a substitute for Greek."

But it seems that this reasonable report of the syndicate was not finally adopted. We learn from the London "Spectator" that the senate of the university decided against the petitioners by one hundred and eighty-five votes against one hundred and forty-five. The "Spectator" discusses this result in a way that is suggestive. It regrets the Cambridge decision, not from want of appreciation of Greek, but because the language is so poorly taught in the university. It declares that it heartily concurs in the following estimate of this study: "It is said that a knowledge of Greek is the only door of access to a certain plane of culture which contains more of the seeds of free life and intellectual energy than all the rest of the intellectual discipline of our schools put together. The genius of the Greek language and literature, it is said, is the genius of freedom. The genius of the Latin language is the genius of authority and law. We believe there is a great deal of truth in this view."

But no such ideal is realized in practice, and the actual results are thus stated: "The fact, no doubt, is that in the present embarrassing wealth of disciplinary studies a great many men, with a real gift for mathematics and physical science, and whose education at the university, so far as it is of any value at all, is carried through in the sphere of mathematics or physical science, take up Greek for the Previous Examination in the most perfunctory way, never attain even a rudimentary mastery of the language or the literature, and even lose something in the thoroughness of their early studies, by entering on a subject which they intend to drop as soon as ever it has answered their temporary purpose. Now, for such as these, the compulsory cramming of a little Greek—enough to enable them, perhaps, to construe decently a little New Testament or a little bit of the 'Anabasis' of Xenophon, after they have been carefully prepared by a tutor—is of no kind of good, and yet takes the place of an acquisition which might be of very real use to them in the career they actually propose to themselves." Again: "The real reason for regretting the decision of the University of Cambridge is the tendency of modern education toward superficiality. Whatever can be done to prevent subjects being taken up which are never to be pursued, and which are never so far followed out that they give those who have entered upon them a new sense of power, should be done. Whatever any university can do to en-

courage the *bona fide* study of Greek, it ought to do. There is no study so cultivating; there are few studies so humanizing; there are not very many studies so ennobling. But just for this reason we think but little of it as a mere whetstone for the understanding of boys; and think a very great deal, on the other hand, of the vast importance of not forcing on any one the necessity for a fragmentary acquisition which is to form no part of his future studies. Whatever else is necessary nowadays, this is most necessary—to prevent that dispersion of the mind over a hundred unconnected morsels of half-knowledge, to which the enormous multiplication of intellectual interests too much tends."

With this demand for thoroughness of study we entirely agree; and it favors the conclusion that of the multitude of subjects undertaken some must be cut off. We say, let those go that are demonstrated and acknowledged failures. The "Spectator's" complaint that Greek is superficially crammed at Cambridge, is but a fresh example of the lamentations of thoughtful men over the same result at the universities for two hundred years. It is not that modern science crowds classical studies so that there is not sufficient time. John Milton made exactly the same complaint when the dead languages and their literatures were almost the exclusive objects of university study, and there was no such thing as the rivalry of scientific studies.

When we consider the force of tradition in a conservative country like England, it is not to be expected that reforms in these rich old universities will move very fast; yet the majority for retaining the customary Greek was not large. Common sense makes headway, but the surprising thing is that the old extravagant claims for this study should still be urged. The "Spectator" affirms Greek to be the most cultivating of all studies, and among the very highest for its humanizing and ennobling influences. The authority of the "Spectator" is outweighed by those who declare that the influence of classical studies is of a very different character. Dr. Whewell characterized it as "narrow and enfeebling"; Macaulay says they have "a tendency to contract the views and deaden the sensibility"; and Sydney Smith speaks of the effect of classical learning as an "elegant imbecility." Certainly that can not be an eminently "cultivating" study which leaves whole important tracts of our mental nature uncultivated; nor can that be the most "humanizing" of studies which puts an ancient fraction of the human race, to be approached only through a dead language, in place of living humanity itself. And are we to regard that study as especially "ennobling" which knows nothing of the conquests, aspirations, and encouragements of the knowledge and life of the present time?

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### THE STUDY OF SEWERAGE IN LONDON.

THE current standards of study and valuations of knowledge are factitious and false. Greek is not so ennobling a study as that of sewerage. To trace out the obscure laws of our own and of surrounding nature, so as to get command of natural agencies for beneficent ends, is the noblest object of study. If life be greater than any of its accidents, what study is so exalted as that which teaches how to save it, to improve it, and to perfect it? When diphtheria makes its dread appearance, and the priceless lives of beloved children are in mortal peril, then comes, with startling emphasis, the true answer to the question, "What knowledge is of most worth?"—it is the knowledge that leads to self-preservation. There is such a thing as life-saving knowledge, but it is not of the classical sort, nor that which is most prized in colleges, even in these later times. It is scien-

tific knowledge that teaches how life is to be protected and prolonged, disease prevented, health heightened, and human existence made more valuable. While at Cambridge they have been assiduous in conserving the more worthless kinds of knowledge and preventing thoroughness in any, in London men have been voluntarily combining to secure the more thorough application of scientific methods to household sanitation. Great multitudes die from unhealthy habitations. Their dwellings are poisoned by noxious emanations that give rise both to slow undermining maladies and to swift malignant diseases. Prominent among these destructive contaminations is sewer-gas, and science has at length grappled with the problem of getting effectually rid of it. It was at first supposed to be an easy task. "Traps" were interposed to prevent the refluence of sewage exhalations, and all was supposed to be well. But disease and death were still rife, and further investigation showed the inefficacy of the mechanical arrangements, and that "foul gases will pass steadily, continuously, and certainly through water in traps." Yet it can not be for a moment doubted that it is possible to obtain absolute protection in dwellings against sewer-air. The difficulty is to get the ignorant classes (including the educated) to give that serious attention to the subject which its gravity demands. The work must be done by the comparatively few who have mastered the science of the question.

Much has been accomplished by such men in this country as well as abroad. But we observe that they are organizing in London for the most effectual prosecution of this important work. A Sanitary Assurance Association has been formed under the presidency of an eminent physician, Sir Joseph Fayrer, the design of which is to unite the professions of medicine and architecture to secure the thorough supervision of sanitary arrangements and drainage in the houses of the metropolis. It seems not to be a movement of evasion by getting up a cry for more "government inspection," but a voluntary association of qualified men who are ready to meet the responsibilities of the task they undertake. Assuming that defective drainage is a "great enemy to public health," and that "there is a terrible absence of all supervision of sanitary arrangements," the Sanitary Assurance Association will make a careful investigation of the health-conditions of houses, and give certificates to those that are in perfect sanitary order. This will be of most important service to the public, because people generally are incompetent to determine what houses are healthy and what are unhealthy. The names of the men who are foremost in this movement are a guarantee that it will be well directed, and, if it achieves the success that it promises, kindred associations will spring up in many other places. A writer, giving a notice of this organization in "Nature," remarks: "It is surely as necessary to be assured against preventable diseases as it is to be assured against fire, and we see from the preliminary prospectus issued that it is intended to give persons who place their houses on the Assurance Register certificates that their houses are in a satisfactory sanitary condition, and to endorse such certificates from time to time; this latter point is of great importance, as it is only by regular inspection at stated intervals that it is possible to ascertain that all continues to work satisfactorily."

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### *A FIELD-NATURALISTS' CLUB.*

We have been much gratified in looking over a modest pamphlet of sixty-two pages that has been sent to us, bearing the title of "Transactions No. 1 of the Ottawa Field-Naturalists' Club." Several young men of that Canadian city, interested in the subject, discussed

for a year or two the possibility of starting a society devoted to the investigation of the natural history of the vicinity, and, having resolved to try it, they issued a few circulars, called a meeting, which was attended by some forty gentlemen, drew up a few rules, and established the association. The object is so praiseworthy, and the plan so well worth imitating in other places, that some account of the operations of this club may prove acceptable to many readers.

The club was organized by the appointment of a President, two Vice-Presidents, a Secretary-Treasurer, and a committee of five other members, all of whom are to constitute a Council of Management. Ladies and gentlemen desiring to join the club may become members by paying a fee of fifty cents a year. The club secures its objects by means of excursions in the summer for making observations and collecting specimens; and by holding evening meetings and *soirées* in the winter for reading papers, discussion, and exhibition, and the display and comparison of natural history objects, the general direction of these proceedings being vested in the Council.

The Council reports at the end of the first year that the work has gone on satisfactorily so as to afford every encouragement for continuing it. Large numbers, of course, do not take to such projects as this; and of those who do, or who join with entire good will, only a small portion have interest enough in the objects to be attained to discharge well the duties of membership. This is always to be counted upon in such undertakings, and should wisely moderate the expectations of the more sanguine. We are informed that the Council met twenty times during the year for the transaction of business, at irregular intervals, as occasion required; and at these meetings there was an average attendance of nearly seven out of nine of the Councilors. This certainly shows well, but the officers were of course picked for their interest in the work. The members were less dutiful. There were five excursions in the course of the summer to attractive points in the vicinity of Ottawa, but only a small part of the members accompanied them. This indifference is thus referred to in the annual report: "The Council feel compelled to express their regret that, although these excursions were to the most interesting places in the neighborhood, and the price of tickets put so low that three of them did not pay expenses, so few of the members thought them worth attending. It does not say much for the interest the members take in the club's work, that, with a membership of over eighty, the average attendance at the excursions should be only thirty, fully one third of whom were visitors; and they hope that during the coming season the excursions will be better supported by the members of the club."

But if the members did not care to go on the summer expeditions, they were less remiss when it came to the winter meetings. The winter course of *soirées* and *conversaziones* was successful in every respect. There was a well-sustained attendance, and the papers read were not only of considerable range but also of serious scientific interest. They were on the following subjects: 1. "Inaugural Address," on the pleasure of understanding common objects; 2. "Graphite of the Ottawa Valley"; 3. "On the Forms and Structures of some Spongillæ found in the Ottawa"; 4. "The Connection of Botany with Mythology"; 5. "Cystidian Life"; 6. "Museum Education"; 7. "On the Contractility of the Spores of Palmella Hyalina"; 8. "Asbestos"; 9. "A Practical Demonstration of the Human Brain"; 10. "Design in Nature"; 11. "Land and Fresh-water Shells of the Ottawa Valley"; 12. "On some Insects captured at our Excursions"; 13. "On some Plants collected during our

Excursions." Abstracts of these papers are given in the "Transactions," and they are of a very instructive character.

If we had space we would print the whole of the admirable "Inaugural Address," by Mr. James Fletcher, who happily remarks in his opening: "One of the chief benefits bestowed by an organization such as ours, is, that it enables one always to know where to find a sympathetic companion. Of all recreations, there is none, to my mind, more enjoyable than a walk in the country with a congenial friend. No kind of intercourse brings you into closer contact with a companion than taking a walk. You can not take ten steps, even with a stranger, without feeling a necessity of saying something, and, if there is anything in a man, you can soon bring it out of him in a country walk. Now, it is very clear that a judicious choice with regard to your companion is a most important matter; but it is not always easy to find one who has the same tastes or takes an interest in the same subjects as yourself. John Burroughs, in 'Winter Sunshine,' writes as follows: 'Professional walkers are very fastidious in choosing or admitting a companion, and hence the truth of a remark of Emerson that "you will generally fare better to take your dog than to invite your neighbor." Your cur dog is a true pedestrian; he enters into the spirit of the enterprise; he is not indifferent or preoccupied; he is constantly sniffing adventure; laps at every spring; looks upon every field or wood as a new world to be explored; is ever on some new trail; knows something important will happen a little farther on; whatever the spot, or whatever the road, he is always satisfied with it. In short, he is just that happy excursive vagabond that touches one at so many points, and whose human prototype in a companion, when such can be found, robs miles and leagues of half their power and fatigue.'

"The most interesting companion in anything is undoubtedly the one who can tell you most about it. Therefore, the best companion in the country must be a naturalist, who can point out objects of interest and explain their beauties and wonders. No one looks upon the world so kindly as he does; no one else gives so much attention to, or takes so much enjoyment from, the country as he does, and he holds a more vital relation to nature, because he is freer, and his mind is more at leisure. Moreover, when a naturalist gets a friend, who is not one, out in the country, he feels a sort of moral responsibility resting upon him to find something particularly interesting to point out, so as to arouse his curiosity, and, if possible, to convert him to the study of 'La Belle Science.' I say particularly interesting, because everything in nature is interesting and beautiful; and I defy any one to bring me a single object, picked up by a country roadside, which is not beautiful, and even exquisitely so—a stick, a piece of straw, a leaf, or a stone, it matters not what, if properly examined and understood, they are all wonderful and lovely."

As before remarked, we refer to the early experience of this club because it may afford guiding suggestions for the formation of similar associations elsewhere. In smaller towns there might not be found so many men cultivated in natural history to sustain such a society as in Ottawa, but that is not essential. In every village of five thousand inhabitants there is cultivated capacity enough, if it were combined, to carry on with some method and to valuable results the work of scientific self-improvement. It may be done to some extent anywhere, in many ways and with few facilities. All over the country there are individuals working alone and to great disadvantage; these would help others and be helped in turn by such combination and coöperation as might be almost everywhere

practicable. The high-school of every town ought to be the headquarters of a Field-Naturalists' Club that shall have for its object to study the natural history of the locality.

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*PHYSICAL EDUCATION.*

IT has not been our habit in this Monthly to make much parade about what we are *going* to do, being quite content with plain statements of what we *are* doing. In this spirit we ask attention to an important series of articles now begun on the subject of "Physical Education," and which may be expected to continue through the year. Dr. Oswald is widely known to the American public as a vigorous, thoroughly-informed thinker, and one of the most racy, incisive, and brilliant writers of the period. He will treat the subject from an original and especially modern point of view. It is a suggestive circumstance that in all modern languages the terms corresponding to what we call physical culture have acquired a specific meaning, being applied nearly exclusively to gymnastics and calisthenics as a branch of practical education. Yet the advocates of physical training in this limited sense were the first to take issue with the educational methods of the mediæval system—of the *anti-natural* school, as it has been justly termed, since its exponents ignored the physical interests of man as persistently as they denied his right to temporal happiness. The founders of the *Turn-bund*, like their Grecian prototypes, held that our highest physical and our highest moral well-being can only be conjointly attained; that health is the principal condition of happiness, and the normal condition of all whose mode of life is not grossly at variance with the simple laws which Nature proclaims in the unmistakable language of our instincts.

These principles Dr. Oswald has applied to the science of *Physical Education* in the widest sense of the word. The serial will comprise an exposition of "Dietetics," the first installment of which is herewith issued, to be followed by chapters on "In-door Life," "Out-door Life," "Gymnastics," "Hereditary Influences," "Clothing," "Remedial Education," etc.

Dr. Oswald has studied the social conditions and sanitary habits of many communities, having traveled in Mexico, South America, and Southern Europe, so that his articles will be enriched with the results of wide and careful personal observation; and it will be found that the author has solved the problem of making a scientific work as attractive to the most fastidious amateur of *belles-lettres* as to the scientific reader and the public in general.

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## LITERARY NOTICES.

THE ATOMIC THEORY. By CHARLES ADOLPH WURTZ, Member of the French Institute. Translated by E. Cleminshaw, F. C. S. New York: D. Appleton & Co. Pp. 344. Price, $1.50.

THERE is a certain sense in which the modern atomic theory may be regarded as the realization of a dream or the fulfillment of a prophecy, or, still better, the verification of a shrewd guess inspired by common reflection and common sense. The notion of matter being all made up of infinitely small particles or atoms was a speculation of the ancient Greek philosophers which has been revived in modern times, and during the present century has become established as a fundamental theory of chemical and physical science. The atomic theory has now assumed a definite form, and binds into unity wide ranges of facts so as to afford a consistent and intelligible view of the constitution of material things. It has been a subject of acute, profound, and protracted controversy, but has grown in clearness and strength with time, as our experimental knowledge of matter has been gradually extended. The most subtle attacks upon it have generally resulted in confirming it, and it has been an instrument of progress even in the hands of those who have doubt-

ed it as an expression of a basal truth in nature. The history of the growth of this conception consequently forms one of the most interesting chapters in the development of scientific ideas; while an exposition of its principles affords the completest exemplification of the views now entertained of the structural and constitutive laws of matter.

All books upon chemistry are now to a certain extent treatises upon the atomic theory, which becomes more and more indispensable as this science increases in extent and complication. The latest phase of chemical progress—the "New Chemistry," as it is called—is entirely pervaded by atomic and molecular theories, while molecular physics is now more completely coordinated with chemistry through the intervention of the atomic hypothesis than has ever been possible before. So important has this idea become, that special treatises are required to deal with it. The "New Chemistry" of Professor Cooke is one of the ablest of these expositions, and has done a most valuable service to education by facilitating the mental transition from an old to a new order of ideas.

Yet the subject is one of so many aspects and such deep and comprehensive significance that it can not be exhausted in any single treatise. There was need for a book like this of Professor Wurtz, which discusses the atomic theory both in its historic evolution and in its present form, with the view of bringing out clearly the influence it has exercised upon the progress of science since the beginning of the century. And perhaps no other man of this age could have been selected so able to perform the task in a masterly way as the illustrious French chemist who contributed the present volume to the "International Scientific Series." He gave himself early to chemistry, and became chief of the chemical department in the Medical Faculty at Strasburg, at the age of twenty-two. He was soon after called to Paris, and became at once connected with its great scientific institutions. After the death of the celebrated toxicologist Orfila, in 1853, and the retirement of Dumas in 1854, their chairs were united in that of Medical Chemistry and given to Wurtz. In 1867 he became a member of the French Academy of Sciences, which had previously awarded him a prize of twenty thousand francs. He has written much upon chemistry, pure and applied, and has paid great attention to the history of chemical doctrines. Among English translations of his works are, "Chemical Philosophy, according to Modern Theories" (1867), and "Theory from the Age of Lavoisier" (1869). "The Atomic Theory" is his last and crowning work, and it has a special authority derived from its author's critical study of chemical progress in the present century.

It is impossible to convey to the reader, in a notice like this, any adequate idea of the scope, lucid instructiveness, and scientific interest of Professor Wurtz's book. The modern problems of chemistry, which are commonly so obscure from imperfect exposition, are here made wonderfully clear and attractive. The statements are sufficiently full without being overdone, the writer's object being simply to make the reader understand the topic that is treated. Many passages might be quoted; here is the account of the "vortex theory," taken from the final chapter of hypothesis upon "The Constitution of Matter":

> In these later times a theory has arisen which seems to give a mathematical demonstration, and even an experimental illustration, of the indivisibility, or rather of the peculiar and eternal individuality, of atoms: I refer to the vortex atoms of Sir William Thomson.
>
> Chemists can form an idea of this vortex motion by recalling to mind the rings which rise in still air whenever a bubble of phosphoretted hydrogen bursts upon the surface of water, and the rings which certain smokers are able to make are familiar to all. An apparatus has been constructed by which they may be produced at will. It is a wooden box, one side of which is furnished with a circular opening, and the other formed of a tightly stretched cloth. In the interior of the box fumes of sal-ammoniac are produced, which are driven out by a sharp blow on the elastic side. A ring of smoke is then seen to issue from the opening, and to move freely through the room. In this ring all is motion, and, independently of the motion of translation, the smoke-particles roll over each other and execute a rotary motion in every section of the ring. These motions take place from the interior toward the exterior of the ring, in the direction of the motion of translation, so that the entire mass of air, or of the smoke which forms the ring, revolves continually round a circular axis, which forms, as it were, the nucleus of the ring. There is this remarkable fact in this rotary motion, that all the particles which

are situated upon one of the curves which can be drawn in each section of the ring, are indissolubly tied down to their circular paths, and can never quit them; so that the whole mass of the vortex ring will be always formed of the same particles. This theorem was proved by Helmholtz in 1858. This eminent physicist has analyzed the vortex motions which would exist in a perfect fluid free from all friction. He has proved that in such a medium vortex rings, bounded by a system of vortex lines,* are formed of an invariable quantity of the same liquid molecules, so that the rings can move, and even change their form, without the connection of their constituent parts ever being broken. They will continue to revolve, and nothing will be able to separate them, divide them, or destroy them. Those existing in the liquid will exist there for ever, and new ones can only be excited in it by a creative act.

The smoke-rings, of which we have spoken above, would give a perfect representation of these liquid vortex rings if they were formed and moved in a perfect fluid. They are not so; but such as can be formed can serve for the demonstration of some properties of matter in vortex motion. They are endowed with elasticity and can change their form. The circle is their position of equilibrium, and, when their form is altered, they oscillate round this position, and finally reassume the circular form. But, if we try to cut them, they recede before the knife, or bend round it, without allowing themselves to be injured. They give, therefore, a representation of something which would be indivisible. And when two rings meet each other, they behave like two solid elastic bodies; after the impact they vibrate energetically. It is a singular fact that when two rings are moving in the same direction, so that their centers are situated upon the same line, and their planes perpendicular to this line, the hinder ring contracts continually, while its velocity increases; the ring in advance, on the contrary, expands, and its velocity decreases until the other has passed it, when the same action recommences, so that the rings alternately pass through each other. But, through all these changes of form and velocity, each preserves its own individuality, and these two circular masses of smoke move through the air as if they were something perfectly distinct and independent. These curious experiments were made in England.†

Helmholtz, therefore, has discovered the fundamental properties of matter in vortex motion, and Sir William Thomson has stated, "This perfect medium and these vortex rings which move through it, represent the universe." A fluid fills all space, and what we call matter are portions of this fluid which are animated with vortex motion. There are innumerable legions of very small fractions or portions, but each of these portions is perfectly limited, distinct from the entire mass, and distinct from all others, not only in its own substance, but in its mass and its mode of motion—qualities which it will preserve for ever. These portions are atoms. In the perfect medium which contains them all, none of them can change or disappear, none of them can be formed spontaneously. Everywhere atoms of the same kind are constituted after the same fashion, and are endowed with the same properties. It is well known, in fact, that the atoms of hydrogen vibrate exactly in the same periods, whether we heat them in a Geissler's tube, observe them in the sun, or in the most distant nebulæ.

Such is, in a few words, the conception of vortex atoms. It accounts, in a satisfactory manner, for some properties of matter, and of all the hypotheses upon the nature of atoms it appears to be the most probable. We see also that it permits the revival of the ancient hypothesis of the unity of matter, and in a more acceptable form than that of Prout's hypothesis. Is the idea absolutely new? No; it was originally conceived by Descartes. So far is it true that, when the perpetual, and perhaps insolvable, problem of the constitution of matter is discussed, the human mind seems to turn in a circle, the same ideas lasting for ages, and being presented under fresh forms to the highest intellects who have endeavored to solve this problem. But is there no difference among these great intellects in their manner of working? Most certainly: some, more powerful, perhaps, but bolder, have proceeded by intuition; others, better armed and stricter, by induction. Here lies the progress and the superiority of modern methods, and it would be unjust to pretend that the important efforts, of which we have had striking testimony, have not made an advance in this difficult problem which was impossible to Lucretius and even to Descartes.

* "Wirbelfäden und Wirbellinien."

† P. G. Tait. "Lectures on some Recent Advances in Physical Science." London, 1876.

THE SKIN IN HEALTH AND DISEASE. By L. DUNCAN BULKLEY, M. D. Philadelphia: Presley Blakiston. Pp. 148. Price, 50 cents.

WE have here an excellent contribution to the series of "American Health Primers." It is as good as its predecessors, which is no slight praise. There are many popular books on that important subject, "The Skin," and several of them meritorious, but this is no reason why Dr. Bulkley should not have made another—because, in the first place, this interesting organ of the body is very important in relation to health, and there are but few people who are at all aware of it. They have not only to be taught, but the lessons must be hammered into them by ceaseless repetition. Hence the need of fresh and unremitting inculcations. Dr. Bulkley's book is to be welcomed on this ground; but it has also a special merit which we have

not before observed in popular skin treatises, and which gives it a special claim upon intelligent readers. It is not only a guide for the preservation of the health of the skin, but it is a kind of medical dictionary on the subject, giving important information which kindred books omit. This feature of the work is thus explained in the author's prefatory note: "He has therefore sought to introduce in its pages not only the medical terms used in reference to diseases of the skin, but also the popular names given, both those which are rightly and those which are wrongly applied. If, therefore, information be sought in reference to any particular matter, it will be well first to consult the index, which has been made particularly full."

A TEXT-BOOK OF THE PHYSIOLOGICAL CHEMISTRY OF THE ANIMAL BODY. INCLUDING AN ACCOUNT OF THE CHEMICAL CHANGES OCCURRING IN DISEASE. By ARTHUR GAMGEE, M. D., F. R. S., Professor of Physiology in the Owens College. With Illustrations. Vol. V. Pp. 487. Macmillan & Co. Price, $4.50.

THIS elaborate work will prove most acceptable to the interested students of physiological and medical chemistry. The activity of research in these departments is very great; thoroughly equipped experimental laboratories are multiplying in different countries, and trained men are concentrating their efforts more and more upon special lines of inquiry. The consequence is, a rapid revision of former results, an extension of observations, and a noteworthy physiological progress. Dr. Gamgee's book is written from the point of view, not of former text-books, but of the latest original memoirs, which are continually referred to, and from the point of view of his own varied and laborious experimental investigations. The volume forms a complete and independent work, though it is intended to be followed by another within a year. It is devoted mainly to the elementary tissues or substances of the body—blood, lymph, and chyle being included in the classification—and it deals with the chemical composition, changes, and processes of these parts. The second volume will treat of the chemistry of the chief animal functions. In the method of the work physiological chemistry has been regarded from the point of view of the biologist and the physician rather than from that of the chemist. In this respect the book deviates widely from the typical plan of works on organic chemistry, where the dominant and classifying conceptions are of the chemical order. The volume will meet a want and be much appreciated as a high-class text-book, and it may be safely consulted by all interested in fundamental chemico-physiological questions.

A PHYSICAL TREATISE ON ELECTRICITY AND MAGNETISM. By J. E. H. GORDON, B. A., C. A. M. B., Assistant Secretary of the British Association. In Two Volumes. Pp. 618. D. Appleton & Co. Price, $7.

OF all sciences that of electricity is perhaps the most purely experimental. The agency has always to be evoked by special manipulation. While the properties of heat have always been more or less known to everybody, nothing was known of electricity for thousands of years. It was a revelation that followed the art of experimenting, and it has advanced at a rate exactly proportioned to the progress of experimental art.

Mr. Gordon in this new work has dealt with the science entirely from this side, limiting his use of mathematics, except in a few foot-notes and appendices, to simple algebraic operations. The work is issued in two beautifully printed volumes, which are profusely illustrated with finely executed engravings, representing the present perfection of electrical apparatus and the refinements of electrical processes, and, besides a clear and concise statement of the main facts of the science, contains an exposition of many of the more recent and important experimental researches.

The author claims that he has aimed throughout to interpret the various phenomena in accordance with the theory worked out mathematically by Maxwell and others, which regards inductive influence as transmitted by strain or vibrations of some kind in the intervening medium, instead of being a direct "action at a distance." In accordance with this purpose, most of the later researches to which attention is particularly given, are those which directly bear upon problems the solution of which will throw light upon what may be termed the mechanism of electrical action. Though not

a popular work, the matter is presented in a manner to be of interest to others than professed students of the science, and should be read by those who desire to know something of the methods and appliances of experimental research in this branch of knowledge.

The subject is considered under the four general divisions of electro-statics, magnetism, electro-kinetics, and electro-optics. Of the first division, a large portion is devoted to the researches of various investigators, including the author, upon the specific inductive capacity of different insulating substances. The subject has important practical as well as theoretical bearings, for upon the low specific inductive capacity of the insulating material used in telegraph cables and wires depends the completeness of the insulation. It is important theoretically, as furnishing evidence by which to test the truth of the theory that induction is transmitted by strain in a continuous medium, as this requires certain relations between the specific inductive capacities and the refractive indices of transparent non-conductors. The work involved is one of considerable difficulty, and though many able experimenters have occupied themselves with the problem, the results obtained differ widely. Mr. Gordon's chapter is a very full presentation of all that has been done, and is one of the most valuable in the work. Besides this investigation, this division contains a clear and complete description of the electrometer of Sir William Thomson, supplemented with a number of drawings of the entire instrument and its various parts.

In the portion of the work devoted to magnetism, descriptions and illustrations of the best modern instruments for measuring magnetic elements—the Kew unifilar magnetometer and dip-circle, and the dip-circle of Mr. Fox for use at sea—are given, with the full instructions for their use. Electro-kinematics includes the various phenomena of voltaic electricity and electro-magnetism, and contains accounts of a number of important and difficult researches. Among these are the determination of the British Association unit of electrical resistance in absolute measure, Blaserne's experiments upon the extra currents, and the investigations of Faraday, Verdet, Weber, and Tyndall upon diamagnetism. A very full and complete description is given of the researches upon the discharge of the electric spark in different gases and at various pressures, and especially of De la Rue and Müller and Spottiswood upon the character of the discharge in high vacua, and the remarkable investigations of Mr. Crookes upon radiant matter. The experimental inquiries of Ayrton and Perry on the difference of potential produced by the contact of dissimilar metals, in elucidation of the question of the origin of electro-motive force in a battery, are also very fully considered.

The division of electro-optics is concerned with a class of important phenomena touching the relation of electricity and light. A full account is given of the discovery by Faraday of the rotation of a beam of polarized light in a magnetic field; and the further researches of Verdet, Becquerel, Kündt, Röntgen, Dr. Kerr, and the author. Mr. Gordon closes his work with a brief sketch of the electro-magnetic theory of light of the late Professor Maxwell, which he states to be that "electro-magnetic induction is propagated through space by strains or vibrations of the same ether which conveys the light-vibrations, or, in other words, 'light itself is an electro-magnetic disturbance.'" The evidence in favor of the theory is found in the similarity in the mode of propagation of both influences, the approximate equality of their velocity of transmission through space, and in the character of conductors. Light-vibrations are at right angles to the line of propagation, and this condition is shown mathematically to hold in the case of induction. The theory requires good conductors to be opaque, which as a fact they are. The most important evidence that both light and induction are transmitted by the same ether is, however, found in the fact determined experimentally that they both have sensibly the same velocity in air and a vacuum. The theory might well bear a fuller exposition than Mr. Gordon has made, and many readers will regret that he has not set it forth at greater length.

SCHOOL AND INDUSTRIAL HYGIENE. By D. F. LINCOLN, M. D. "American Health Primers." Philadelphia: Presley Blakiston. Pp. 156. Price, 50 cents.

WE cordially welcome these cheap, use-

ful manuals on topics of vital moment to the people, but the danger is that they will be too much cheapened, and become inadequate to the ends they propose. In the present case we think a mistake has been committed in dividing this book into two parts, the first treating of "School Hygiene," and the second of "Industrial Hygiene." These topics are too large and too momentous to be both dispatched in a fifty-cent primer. The author has done as well as he could with the subjects in the space assigned, and the book undoubtedly contains a good deal of important information well presented. The first part, comprising 106 pages, is much the best, but it would have been still better if he had devoted the other fifty pages to the same subject; various points that he has treated should have been much more amplified, and "Industrial Hygiene" dealt with in a separate book.

THE OCEAN AS A HEALTH-RESORT: A HANDBOOK OF PRACTICAL INFORMATION AS TO SEA-VOYAGES FOR THE USE OF TOURISTS AND INVALIDS. By WILLIAM S. WILSON, L. R. C. P. Philadelphia: Presley Blakiston. Pp. 260. Price, $2.50.

IN this age of restlessness, when "everybody goes to Europe," and the trip around the world is becoming commonplace, a special book on the requirements and experiences of sea-travel and its hygienic influence may be useful to a large number of persons. To the unpracticed traveler a first sea-voyage is generally a very uncomfortable experience. Aside from sea-sickness, there are many more inconveniences and disagreeablenesses than are compensated for by the novelty of the situation; and, if a person is out of health, these effects are naturally aggravated. The author of this book assumes that there would be a great mitigation of sea-troubles if there was more information about them to guide the traveler; and so he has attempted to bring together various hints, explanations, and practical directions by which sea-life may be made most comfortable. He gives instruction as to the outfit, and what is to be expected in the way of accommodation, food, and amusement in long voyages. The diseases to which sea-voyages are supposed to be favorable are considered, and the various curative effects of the ocean-climate. The most suitable routes for particular hygienic objects are pointed out, and the choice of ships and the best times of the year for voyaging are also noticed. There are chapters on the "Management of the Health at Sea," on "Occupations and Amusements at Sea," on "Objects of Interest at Sea," and on "The Meteorology of the Ocean." The book is English, and the author assumes the voyage to Australia by the Atlantic route to be, on account of its length and many advantages for invalids, the typical health-voyage; but he gives many particulars concerning various other sea-routes, so that those inclined to ocean-travel can have a choice of courses, and make their preparations accordingly. The volume is well worth consulting before going to sea, and, as it is not large, it may be found profitable to take it along.

THE PHILOSOPHY OF MATHEMATICS, WITH SPECIAL REFERENCE TO THE ELEMENTS OF GEOMETRY AND THE INFINITESIMAL METHOD. By ALBERT TAYLOR BLEDSOE, LL. D. Philadelphia: J. B. Lippincott & Co. Pp. 248.

THIS work appeared several years ago, but its discussion of mathematical questions is of permanent interest. It is not a general philosophy of mathematics, such as might be based upon the historical development of mathematical conceptions, but it is limited to the higher mathematics, and is a critical inquiry into certain controverted questions which have long exercised the ingenuity of the learned. One of the main objects of the book is to combat the idea that the circle is to be regarded as but a regular polygon of an infinite number of sides. The book abounds in mathematical erudition, and has much interest for the devoted cultivators of the science.

THE ORTHOËPIST: A PRONOUNCING MANUAL. By ALFRED AYRES. New York: D. Appleton & Co. 1880. Pp. 207. Price, $1.

THE author has in this manual given the pronunciation, as determined by the best usage, of a large number of English words that are frequently mispronounced. The list contains about thirty-five hundred words, and includes the more commonly used foreign ones. The recognized authorities are cited in support of the pronunciation given, and when they differ the preponderant opin-

ion is indicated. When the author inclines to a pronunciation differing from the received one, what he regards as sufficient reasons are given for the preference. The book is in compact form, and will be found a very desirable one to have at hand.

WHAT TO DO FIRST IN ACCIDENTS OR POISONING. By CHARLES W. DALLAS, M. D. Philadelphia: Presley Blakiston. Pp. 68. Price, 50 cents.

THIS is a brief but well-digested manual of directions as to what to do in accidental emergencies that are liable to happen to everybody. It is extremely brief, but pointed and practical.

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### PUBLICATIONS RECEIVED.

The Omori Shell Mounds, reprinted from "Nature"; and Some Recent Publications on Japanese Archæology, reprinted from "The American Naturalist." By Edward S. Morse. Salem, Mass. 1880

The Feeling of Effort. By William James, M. D. Published by the Boston Society of Natural History. 1880. Pp. 32.

The Electric Laryngoscope. By A. Wellington Adams, M. D. Reprinted from "Archives of Laryngology." Pp. 5.

Thirty-seventh Annual Report of the New York Association for Improving the Condition of the Poor for the Year 1880. Pp. 47.

Hollow Brick. Solution of Equations and Interpolation in Series; Foundations; Arches in Masonry and Bridges. Washington: Government Printing-Office. 1880. Pp. 33. Illustrated.

Higher Education of Medical Men. By F. D. Lente. M. D. New York: C. L. Bermingham & Co. 1880. Pp. 16.

Current Views and Notes of Forty Days in France and England. By John Swinton. New York: G. W. Carleton & Co. 1880. Pp. 45. 25 cts.

Summary of Substantialism, or Philosophy of Knowledge. By Jean Story. Boston: Rand, Avery & Co. 1880. Pp. 113.

First Annual Report upon Useful and Noxious Plants. By Professor T. J. Burrill. Springfield, Ill. 1880. Pp. 9.

On the Identity of the Ascending Process of the Astragalus in Birds with the Intermedium. By Professor Edward S. Morse. Published by the Boston Society of Natural History. 1880. Pp. 10. Illustrated.

Annual Report of the Chief of Engineers U. S. Army. 1880. Pp. 264.

Ontology. By Emanuel Swedenborg. Translated by Philip B. Cabell, A. M. Philadelphia: J. B. Lippincott & Co. 1880. Pp. 40.

The Geology of Hudson County, New Jersey. By Israel C. Russell. From the "Annals of the New York Academy of Sciences." Pp. 53. Illustrated.

The Relations of Science to Modern Life. By Henry C. Potter, D. D. New York: G. P. Putnam's Sons. 1880. Pp. 29.

Telegraphic Measurement of Differences of Longitude by Officers of the U. S. Navy, 1878 and 1879. Washington. 1880. Pp. 87. Illustrated.

Report on the Geology of the High Plateaus of Utah, with Atlas. By C. E. Dutton. Washington: Government Printing-Office. 1880. Pp. 307. Illustrated.

The Publishers' Trade List Annual. New York: F. Leypoldt. 1880. $1.50.

The Scientific Basis of Spiritualism. By Epes Sargent. Boston: Colby & Rich. 1881. Pp. 372. $1.50.

Medical Heresies. By Gonzalvo C. Smythe, M. D. Philadelphia: Presley Blakiston. 1880. Pp. 228. $1.25.

A New School Physiology. By Richard J. Dunglison, M. D. Philadelphia: Porter & Coates. 1880. Pp. 314. $1.50.

A Practical Treatise on Nervous Exhaustion. Second and revised edition. By George M. Beard, M. D. New York: William Wood & Co. 1880. $1.75.

Diphtheria. By Rollin R. Gregg, M. D. Buffalo: Printed by Matthews Brothers & Bryant. 1880. Pp. 133. For sale by Author. $1.50.

Handbook of Chemical Physiology and Pathology. By Victor C. Vaughan, M. D., Ph. D. Third edition, revised and enlarged. Ann Arbor. 1880. Pp. 351. Illustrated. $3.

Transcendental Physics. By Johann Carl Friedrich Zöllner. Translated by Charles Carleton Massey. Boston: Colby & Rich. 1881. $1.50.

British Thought and Thinkers. By George S. Morris, A. M. Chicago: S. C. Griggs & Co. 1880. Pp. 388. $1.75.

The Beautiful and the Sublime. By John Steinfort Kedney. New York: G. P. Putnam's Sons. 1880. Pp. 214. $1.25.

Is Consumption Contagious? By Herbert C. Clapp, M. D. Boston: Otis Clapp & Son. 1881. Pp. 178.

Report of the Commissioner of Education for the Year 1878. Washington: Government Printing-Office. 1880. Pp. 730.

The Care and Culture of Children. By Thomas S. Sozinskey, M. D., Ph. D. Philadelphia: H. C. Watts & Co. 1880. Pp. 484. $2 50.

Practical Plane Geometry and Projection. By Henry Angel. Vol. I. Text. Pp. 352. Vol. II. Plates. $3.50.

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## POPULAR MISCELLANY.

**The Maxim Electric Light.**—Some new electric-light apparatus has been in use in this city during the past month, which carries the solution of the problem of reducing this light to a form in which it will be available for the purpose of general lighting, further than any previous devices. It consists of a new incandescent lamp, in which the main feature is the means of compensating for the waste of the carbon strip, and an appliance by which the strength of the current is automatically varied in accordance with a varying number of lamps in circuit. The lamp is in appearance much like that of Mr. Edison's, the carbon strip being, however, bent into the form of a letter M, or of a Maltese cross, instead of a simple

bow. The carbon, which is made from paper or wood, is not placed in a vacuum, but in a rarefied atmosphere of gasoline, the idea involved being that, as the strip wears away under the action of the current, it will be continually renewed by the free carbon of the dissociated hydrocarbon vapor. This deposited carbon forms a hard, compact layer which seems to greatly increase the durability of the strip, and also the amount of light which it will yield under a given current. None, it is stated, have broken, even when forced much beyond the incandescence they are intended to bear, and, owing to the compensating action of the gasoline, it is anticipated that the lamps will be permanent. The platinum wires supporting the carbon strip are not fused into the glass of the bulb, as has been the case in previous incandescent lamps, but are surrounded by a slightly elastic cement, which it is averred preserves a good joint. The light given by the lamp is but slightly yellow, is quite pleasing to the eye, and is fairly steady. It has, however, a perceptible vibration, different from the irregular flicker of gas, but more painful, and which it seems impossible to eliminate, as it is due to the necessary variations of the engine-speed. As to cost, the inventor, Mr. H. S. Maxim, claims that he is able to produce ten lights of twenty candles each per horse-power. Professor Henry Morton, of the Stevens Institute, in a paper read before the American Academy of Science, at its recent meeting, stated that, experimenting with one of these lamps, he found that, when it was giving a light of forty candles, the expenditure for power was at the rate of 240 candles per horse-power. A twelve-candle light was at the rate of 136 candles, and, at 49 candles, was at the rate of 426 candles for the same power; while, when the lamp was forced to 98 candles, the expenditure was at the rate of 607 candles per horse-power. He also bore testimony to the value of the gasoline vapor in building up the carbon strip. It is doubtful, however, if the gasoline will prove in practice as free from disadvantage as expected. It will probably deposit in the form of a film on the glass, that may in time so obscure the light that a new lamp will be necessary. Such a deposit seems to have already taken place in some of the lamps at present on exhibition. The regulating device is quite simple in construction and certain in action. Its general mode of operation is as follows: The field magnets of the machine supplying the currents to the lamps are excited by another machine. The current furnished by this latter is varied in accordance with the number of lamps in circuit, by shifting its commutator brushes to and from the position in which they take off a maximum and minimum current. This shifting of the brushes is done by means of simple mechanism, actuated by an electro-magnet placed in the lamp-circuit, and therefore subject to the same conditions as the lights. Numerous trials have shown that this regulator is entirely reliable, and the adjustment of the current is so delicate that no observable difference has been detected in the light of a lamp whether one or sixty were in circuit.

**The German Anthropological Society.**—The eleventh meeting of the German Anthropological Society was held at Berlin, August 5th to 12th. The greater proportion of the papers read during the sessions related to relics discovered in Germany and the neighboring countries, most of which were newly found, or newly reported upon. Among the subjects of these papers were prehistoric earthworks and fortifications in Schleswig-Holstein; a Frankish burial-ground near Worms, in which burials in rows and in several courses of bodies were notable features, and where dogs and horses were found buried with the men, together with vessels of clay and glass of extraordinary size and beauty, and a unique bronze cup adorned with Christian emblems; the Frankish castle of Schlosseck in the Isenach Valley near Dürkheim, hitherto wholly unknown; a report by Professor Virchow upon the results of statistical researches into the color of the skin, hair, and eyes, illustrated by maps and tables; prehistoric charts of Germany by Professor O. Fraas; the German Runes, by Dr. Henning, of the University of Berlin. Dr. A. Bastian, who had returned from a journey of more than two years, undertaken for the study of facts relating to anthropology, spoke of the immensity of the task of perfecting the science, which he realized more completely than

ever. The present generation has to lay the foundation of the study and leave the task of building it up to posterity. We enjoy many advantages from intercourse with primitive people which those who will come after us may not possess; and we have much to do in gathering and preserving facts which are passing away with every year, day, hour even, lest through carelessness or neglect they shall disappear utterly. Every gap thus permitted will be painfully regretted in the future, when a detailed review shall be undertaken of the diversity of variations in which the human race has exhibited itself on the earth. The speaker insisted upon the necessity of ethnologists traveling among these primitive peoples, and spoke particularly of his observations in Polynesian mythology. The Polynesian circle of thought, he said, is, after the Buddhist, the most extensive on the earth. A surprising homogeneity prevails throughout the length and breadth of the Pacific Ocean, and still more widely if we consider Oceania in its full sense, with the inclusion of Polynesia and Melanesia. It may be said that this unity prevails over about one hundred and forty degrees of longitude and seventy degrees of latitude, or over one fourth of the globe. We can not ignore so interesting a phenomenon. A direct relation exists between the mythologies of all peoples and their religious notions, and the same is the case in Polynesia. Accounts of the mythologies of the primitive tribes generally afford senseless caricatures so long as we are not acquainted with the religious notions around which they play. The knowledge of these beliefs is not easily gained, for the priests hide their doctrines under symbols which only the initiated can understand. It requires a long residence in the country and a winning of the confidence of the priests to such a degree as to induce them to communicate the traditions that have been handed down to them in secrecy. In all the Polynesian literature that we possess there is nothing that goes to the heart of their religion beyond a few disconnected fragments which have been taken down by a half dozen writers; and the cry is already going up that it is too late; that the holders of the uncontaminated traditions are passing away and carrying with them to the grave the knowledge they might impart. Professor Bastian stated that he had been able by a combination of favorable circumstances to gather a few of these documents, out of which he hoped to be able to effect a partial reconstruction of the Polynesian religious system.

**Studies of Young Apes.**—H. Schneider gives, in "Kosmos," an account of his observations of the habits and the development of the faculties of a young Javanese ape, which he had bought for purposes of study. The animal, when taken home, won at once the affection of Herr Schneider's wife, to whom he had anticipated it would be unwelcome. When awakened from its sleep in the woman's lap, it acted almost precisely as children do in similar circumstances—stretched its limbs, yawned with a very perceptible sound while its eyes were closed, rubbed its eyes, and scratched itself; then suddenly bounded up and went into its cage. It was not long before Chega—so it was named—began to show her dexterity. While playing in the room one day, she sprang upon the table, and before her master could prevent it, took up a half-filled cup of coffee from before him, ran to the sofa, and, standing upon its back, quietly drank the coffee, having finished which, she jumped down without having spilled a drop of the liquid. Her behavior was generally that of a spoiled child. When pleasantly spoken to, she was agreeable and playful; but if anything was denied her, or taken away from her, she would cry out, strike with her hands and feet, and go straight to the object and get it if she could. She would sit on her master's arm as he was playing at cards, and turn over the cards; or she would search in his pockets, looking most often for his watch, which she was very fond of getting. When she saw an effort made to catch her, she would mind no call, but would hide in the farthest corner. If capture was imminent, she would make a rueful face, with clinched teeth and parted lips, and utter a smacking sound. The danger over, a friendly word would restore her amiability at once. She would clasp her master's neck, put on a comical expression, and throw kisses at him. When spoken of by her master to a third person, even if she

seemed to be in a deep sleep, she would look up with signs of pleasure and utter a whimper of acknowledgment. When she had to be whipped, she would give up at once when caught, though never to any one but her master; but if his wife was in the room, she would run to her for protection, sounding a note of triumph while the master was looking out that she did not bite him in getting away from him. She was always betrayed by her guilty consciousness when she had done anything wrong, even if no one had observed her; and if detected, would act as a child acts under the shame of guilt. She was not greedy in eating except when denied something; then she would seize it with both hands, and stuff her cheeks so full that it would take a considerable time to eat what she had put away. At her regular meals she ate slowly. If a cup of milk was placed in the cage so that the shadow of one of the bars of the cage was thrown over it, she would look at the shadow, grasp after it, and then look astonished to find that she had not got hold of it, and would not drink until she had examined the cup from every side. In eating, she rejected the thinnest shells, the strings of beans, and the skins of nuts. She was induced to take medicine by pretending that she must not have it. If her master wished to give her rhubarb, he would play with a piece of the drug while Chega looked on wistfully; then seem to snatch it away so that she should not get it, and let it drop, as if accidentally, out of his hand, when in an instant it would be seized or swallowed; or, if not already swallowed, would be if an effort was pretended to take it away. Chega was fond of her master's Spitz dog, and had many frolics with him. Once they were chasing each other between the sofa and the table, when the ape got into a position between the two where the dog could not follow her, but staid upon the table looking at her. In an instant she took hold of the table-cloth with both hands and brought it down, with the dog in it, upon the floor. While the astonished dog was trying to release himself from the folds of the cloth, Chega ran to the window-sill and clapped her hands in evident pleasure over the success of her trick. Chega slept with her master for three years, lying with one of her arms around his neck, while her other hand was in his. To prevent her getting away in the night, her master fixed a cord to her neck, so that she should wake him when she moved. She soon learned the secret of the cord and how to unhitch it, and would unhook the neck-band, take out a pin, lay the whole carefully aside, and spring up to go, when she would be stopped. Chega seemed to have dreams, as men and children often do, of falling from a height, and would draw up her limbs with the convulsive motion that all are aware of. Herr Schneider believes that his pet exhibited in a wonderful degree the faculties of reflection and comparison. Dr. Julius Falkenstein has given, in his account of the German Loango Expedition, a narrative of the early life-history of the gorilla Mpungu, which was obtained and brought home by the expedition, and was afterward exhibited in the Berlin Aquarium. While in Africa, the young animal was kept as free as possible from other than natural influences, so that its habits might be studied as accurately as was practicable. Mpungu gave a contradiction to the reports of the fierce and untamable character of the gorilla, for he soon became accustomed to the persons around him, showing a real dependence upon them and confidence in them, and was allowed to run about with no more care than a child. He gave no evidence of evil or malicious propensities, but had a will of his own, and distinct tones of voice in which to express his feelings. The representations of Du Chaillu concerning the gorilla's beating his breast were confirmed by this animal. The action indicated an excess of physical good feeling, and was never observed while the animal was in Europe, because he never enjoyed good health there. Pleasure in bodily vigor was also frequently exhibited in reelings and tumblings like those of a drunken man. When anything was given to the young gorilla in a cup or glass, he would take it up carefully with both hands, bring it to his mouth, and, having drunk, set it down as carefully; and he was never known to break a dish. Yet he was never taught how to use dishes. He took in eating only as much food at a time as he could hold between his thumb and two fingers, and would observe the removal of the mass of food with indifference;

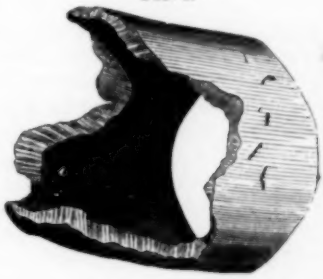
but, if not helped, he would glance at the dishes around him with an impatient murmur, and try to attract the attention of the waiters with a cough or by touching them. If he drank out of a vessel which he could not lift, he would bend down to it without touching it with his hands or disturbing it. He was particularly neat, seemed annoyed if anything fell upon him or stuck to him, and would pick it off carefully, or would hold up his hands and let some person pick it off; he was free from odors, and was very fond of playing and splashing around in the water. His most prominent individual peculiarities were good humor and cunning. If punished, he never resented it, but would look his feet together and look up with an expression that disarmed all ill feeling. When he wanted anything, he could make his wish known as expressively and persuasively as any child. If it was not granted he would not give it up, but would wait for his chance with every evidence that he had a plan in his head. Thus, if he wanted to go out, and was refused, he would seem to submit and lie down in assumed indifference not far from the door, raising his head occasionally to see if his opportunity had come, and would gradually draw nearer to the door, keeping careful watch all the time, and at last would go out so quickly that no one could stop him. Whenever he intended to steal sugar or fruit from the cupboard, he would keep looking in the opposite direction till he was not observed, and then would go directly to the cupboard, open the door, and, having shut it behind him, would take out carefully whatever he wanted and eat it as quickly as possible. If detected, he would run away, and his whole demeanor would indicate that he knew he was doing what was forbidden. He took great pleasure in drumming on hollow things, and seldom let an opportunity pass of doing so. Unaccustomed noises were annoying to him. Thunder, the pattering of the rain on the awnings of the ship, the sound of the trumpet and the pipe, gave him so much pain that it was an act of mercy to get him out of hearing of them as quickly as possible. Mpungu declined after he was taken to Europe, and died in a little more than two years after he was caught.

**The Stone-Grains in Fruit.**—Henry Polonié considers, in "Kosmos," the nature of the gritty particles in pears and other fruits of the apple family. Each of these bodies consists of several cells which may be called stone-cells, and which have walls of considerable strength, traversed by canals. The stone-cells are widely distributed through the vegetable kingdom, and form an essential part of the framework of many plants. In these cases they perform mechanical functions, as they do also in grapes or stone fruits, where they form strong walls protecting the seed. The mechanical office does not, however, appear in the pear, for the stone-grains are scattered irregularly in the pulp of the fruit. M. Polonié suggests that they may be the rudimentary remains of a stone casing to the seeds of some ancestor of our present cultivated and wild pears. It is in favor of this theory that the stony pear-grains are not evenly distributed through the whole fruit, but are thickest in a zone surrounding the seeds, and where we should expect to find the shell of the stone if the pear was a proper stone-fruit. By bringing together the different varieties of cultivated and wild or wood pears, we might arrange a series of fruits in regular gradation, from a luscious pear with hardly any stony grains down to a tough wood-pear, in which these grains would be so close as to touch each other all around. If the latter pear is dried, the stony surrounding becomes so hard that it is difficult to cut through it. M. Polonié has found this to be the case with certain wild pears which he has observed. This theory is also supported by the analogy of certain genera related to the pear whose fruits inclose stones, as the medlar, which has fine stony seeds; certain species of thorn, in which the seeds are merged into one kernel surrounded by a stony envelope, and some exotic genera, as the East Indian stranæsia, in which all the seeds are surrounded by a common stony envelope. The quince has also gritty particles, which are distributed similarly with those of the pear; and a quince from the shores of the Caspian Sea, which is preserved in the herbarium at Berlin, has its stone-grains thickly grouped in a hard mass surrounding the seeds, like the wood-pears mentioned by M. Polonié.

**Craniology of the Africans.**—M. de Quatrefages recently explained to the French Academy of Sciences the results of the researches of M. Hamy on the craniology of the African races. Far from all the negroes of Africa being dolichocephalous (or long-skulled), there exist on the continent diverse populations, forming two distinct groups, which pass in succession from the sub-brachycephalic (moderately short-skulled) to the mesocephalic (medium-skulled) and to the sub-dolichocephalic, and finally to the true dolichocephalic type. In other words, the relation of the transverse diameter to the antero-posterior diameter of the skull goes on progressively diminishing. M. Hamy has also studied the race of the dwarf negroes, and finds that their skulls are quite as much arched as those of the other human races. Their stature nearly approaches that of the Mincopies of the Andaman Islands, but it is superior to that of the Bushmen, whose height often falls to one metre (three feet three inches), sometimes to 1·14 metre (three feet eight and a half inches). This race probably approaches the true brachycephalic type. M. Hamy joins in a single race the Noubas, the Fourahs, the Gallas, the Nyam-Nyams, etc., and attaches to the same group, which is generally Eastern, the Haoussas who live west of Lake Tchad, although a population craniologically distinct is situated between them.

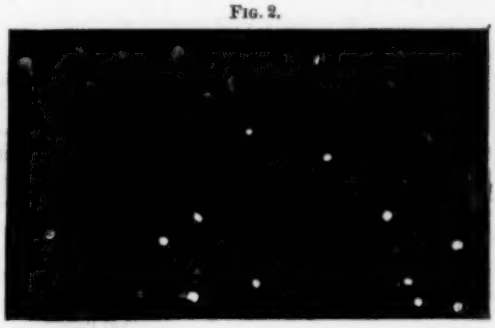
**Rats and Lead Pipes.**—One of the best foreign authorities on sanitary engineering, Dr. William Eassie, has an interesting letter in a late number of the "Sanitary Record" on the destruction of lead pipes and flashings by rats, mice, and even timber-worms. He relates several cases, either seen by himself or brought to his attention by others, in which lead waste-pipes were perforated with veritable rat-holes, thus admitting not only sewer-gas but the rats themselves into the house. Fig. 1 is reproduced from Dr. Eassie's letter, and represents a piece of two-inch lead pipe a quarter of an inch thick, which was once a part of the waste-pipe of a sink in a house in London. This pipe terminated in an old brick drain infested with rats. "The rats obtained ingress to the house by way of this pipe, that is certain; and on taking up the floor some hundreds of these animals were destroyed and many missing articles

FIG. 1.



recovered. The marks of their teeth are very plainly exhibited, as may be seen by a glance at the woodcut, which does not exaggerate them in any way." Fig. 2 represents a piece of lead flashing obtained by Dr. Eassie from the roof of an infirmary in the north of England. The woodwork below had been first destroyed by wood-borers, and the light, shaded marks in the cut show

FIG. 2.



where the acid of the destroyed wood had partially eaten away the lead. The white holes are actual perforations to the open air. Other instances of a like character are given, and all go to show that lead, where so exposed, is not a safe plumbing material.

**A Musical Valley.**—In an essay on "The Singing Valley of Thronecken," Herr H. Reulaux has described an enduring sound like the ringing of bells, which he heard while engaged in a deer-hunt in an elevated wooded valley in the Rhine Province. He had before heard sounds in the valley, re-

sembling those which might come from a church in some town hidden in its recesses; but there was no such town in the neighborhood. On the occasion which he especially describes, he took his place as one of the hunters in a wood of large beech-trees lying against the slope of the mountain, and was treated all the time he stood there to a succession of peals as of bells, coming one upon another, swelling up and dying away, and sounding together in many varieties of modulation, and in all the different stages of progress. At times the impression of the music was so strong as to hold him almost breathless; then a new wave would sweep up, beginning like the soft breathing of an organ-pipe, rising to the swell of a harp, and closing with the overtone of the octave, as if it were drawn out by some master of the violin. When the hunter returned to the same place toward evening, he heard the same sounds. One other of the hunters remarked them, but the rest were absorbed in their sport. A forester blew the tone of C on his horn, and it was repeated in the bell-peals. The tones evidently originated in the mouth of the valley and died away in its upper part. They were produced by the passage of the wind through the valley, and modified by its configuration, the character of the rocks, and, probably, by the wood.

**Animals or Plants?**—In the course of a lecture on "Plants that prey upon Animals, and Animals that fertilize Plants," delivered at Leeds recently, by the Rev. W. H. Dallinger, the lecturer explained that there were animals—definitely proved to be such, and with which every zoölogist was familiar—that were so lowly in their being that they possessed no definite form. They revealed to the most refined scrutiny no organization. They moved, but without muscle; they crept, but without limbs; they felt, but without discoverable nerves; they devoured without mouths; they digested without stomachs; and they had all the properties of life, but were without trace of organized structure. It was their habit to associate with even these lowly creatures, because they were animals, a measure, at least, of consciousness and volition. But, on the other hand, there were plants of the highest and most compact structure in which delicacy of organization, refinement of mechanical contrivances, and adaptation of means to ends, were combined; and yet, because they were vegetables, they were accustomed to assume that they were without consciousness, and devoid of will. But what were the facts? Zoölogy at the present day was in the highest sense a science. Its facts had a precision and value unrivaled, and from these they were bound to say that the old landmarks were utterly incompetent. The animal and vegetable kingdoms could not be separated, and the two marched on in one organic whole. To the popular mind he had no doubt this would appear arrogant. To common observation the distinction between the plant and the animal was believed to be sufficiently clear. Between an ox and an oak-tree there was an unmistakable difference. A cabbage and a swallow were not very easily confounded. This was quite true; but if the entire of what was known as the animal world were laid against the whole of what was known as the vegetable kingdom, it would be seen that there were no features belonging to the one which were not in some sense shared by the other. There were vegetables controlled by movements which in animals would be called instincts. They could intoxicate a plant as they could intoxicate a man or beast; they could paralyze it with pain or chloroform, and could kill it with an electric spark. There were some plants which depended for existence on the animals they entrapped, and to this end they were endowed with a susceptibility more delicate than that of the human body, while they could distinguish between food which would nourish them and substances which would not. It was not too much to say that the extinction of insects would lead to the extermination of the most beautiful plants existing on the globe; while the extinction of these beautiful plants would, in like manner, be the ruin of the majority of insects.—*English Mechanic.*

**Efficacy of Sanitary Improvement.**—Two reports have recently been published in Great Britain which illustrate what has been accomplished in lessening the prevalence of disease and prolonging human life by measures of sanitary improvement. The improvement trustees of Glasgow have given out a statement showing that the

average death-rate per one thousand persons has been reduced nearly eleven per cent. in twelve years, under the operation of the sanitary measures instituted by them, which included the demolition of unwholesome dwellings, and the provision of ample hospital space for small-pox and fever cases, and for the control and limitation of epidemic disease. They also cite from the report of the Registrar-General figures showing that a similar improvement in sanitary condition has been wrought in other towns: in Edinburgh of fourteen, in Dundee of twelve, in Aberdeen (where the death-rate was already very low) of three and one-half per cent. The figures given of a number of English towns show a less striking rate of improvement. Dividing the twelve years into two groups of six years each, it is found that, in twelve leading towns, 61,000 fewer deaths occurred in the second six years (1873–'78) than would have occurred under the higher death-rates of 1867–'72. The sanitary officer of Manchester has reported to the bishop of the diocese that, under the operation of the measures which have been adopted in that city, "typhus and typhoid fever, though not absolutely extinguished, are of comparatively rare occurrence, and nearly all other infectious diseases have been largely reduced in amount, while the general health has been improved."

**An Antarctic Expedition.**—The Italian Geographical Society has projected an Antarctic exploring expedition, to be under the command of Lieutenant Beve, an Italian officer who was with Nordenskjold during his last expedition. Very little is definitely known concerning the Antarctic regions, and they offer numerous problems to be solved. They have been touched upon, but can hardly be said to have been explored, by several navigators since Captain Cook crossed the Antarctic Circle in 1774–'75, including Lieutenant Wilkes with the American Expedition, but the results of the observations made upon them do not agree. Even the Challenger Expedition, in 1873, added but little to our knowledge of them. It is still not fully settled whether the region be only an immense mass of water or whether it contains another continent. Lieutenant Wilkes believed that he had established the existence of a continent, but Sir James Ross a year later sailed over two of the positions assigned by him to the continent, while he found the extensive Victoria Land with mountains 14,000 feet high and an active volcano. The great ice-sheet, which certainly covers the land, needs to be studied and compared with the ice-sheet of Greenland. Lieutenant Beve and his companions hope to winter in the Antarctic region, and to be more successful in studying its character than their predecessors have been.

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## NOTES.

A HOLTZ frictional electric machine, said to be the largest ever made in this country, has recently been constructed by a well-known firm manufacturing physical and chemical apparatus in this city. The revolving glass disk is forty and the condensing stationary disk forty-six inches in diameter. It is provided with the continuous charging apparatus of Van Brunt, which is a very considerable improvement over the ordinary means of charging by rubbing a disk of vulcanite with a skin by hand. The machine gives a discharge over twenty inches long, and, on account of the facility of charging, can be satisfactorily worked in almost any weather.

AT a late meeting of the California Academy of Sciences, Mr. W. N. Lockington read a paper on fishes, in which he states that of three hundred and eight species, mostly marine, occurring on the Pacific coast, all but thirty-seven are found in California. Of the five hundred and forty fresh-water species known in the United States, but thirty-seven are found in that State.

THAT ants can make themselves heard as well as felt, is asserted by Mr. S. E. Peal, who writes to "Nature" that he has observed in several varieties of this insect the power of producing distinctly audible sounds. Two kinds of ants, one brown the other black in color, could be heard a distance of twenty or thirty feet, the noise being produced by scraping the horny apex of the abdomen three times in rapid succession against the dry leaves of the nest.

DR. EPHRAIM CUTTER describes in the October number of the "American Monthly Microscopical Journal" an interesting study he has lately made of the central surface-waters of several ponds and lakes in Massachusetts. He found, contrary to the general opinion, that the waters in the middle of ponds or lakes contain large numbers of mi-

croscopic forms of both vegetable and animal life.

THE experiment of irrigating the lands at Genevilliers with water from the sewers of Paris appears to be working successfully. In answer to protests which have been made against applying a similar irrigation to the forests of St. Germain, the engineers say that the apprehensions that have been expressed on the subject are exaggerated. Many buildings have been put up at Genevilliers since the sewer-waters were taken there, but the inhabitants have never been sick. Moreover, since the prevailing winds are from the west, places lying east of the irrigated district should be the ones most troubled with the infection if there were any; but no complaint has come from Clichy, which is thus situated, while the barren tracts on which it looked have been converted into a fertile plain.

THE French journals tell of some perfectly fresh meat that became phosphorescent. Some cutlets of raw pork shone so brightly in the kitchen that it was possible by the aid of the light to tell the time by the watch. The butcher from whose shop they came said that all the meat of which they were a part of the stock became phosphorescent within a short time after having been put into his cellar. The phosphorescent meat did not otherwise differ in aspect or odor from common meat; it had not been exposed to a temperature of more than 50°, and entire freshness seemed to be a condition of phosphorescence, so that when the meat began to smell it ceased to be bright. The phosphorescence generally disappeared on the sixth or seventh day.

M. L. CRULS has communicated to the French Academy of Sciences notes of observations which he has made at the Imperial Observatory, Rio Janeiro, on stars unfavorably situated for observation from the Northern Hemisphere. Some of these stars appear to possess a slow but well-defined orbital motion, amounting in some instances to about six degrees retrograde in forty-three years. They have been observed heretofore only by Sir John Herschel at the Cape of Good Hope, and by Captain Jacob at Poonah, India, and it is from a comparison with their observations that he has deduced the fact of motion.

THE Royal Society has this year awarded the Copley Medal to Professor J. J. Sylvester, at present occupying the chair of Mathematics in Johns Hopkins University.

M. DE LESSEPS has a plan for the civilization of Africa by telegraph. Stations for entertainment and for scientific purposes are to be established at points between the coasts and the interior. Thus a party has already arrived in the Oussagura to establish a station to be connected with Zanzibar, and another party has been commissioned to establish a station on the Ogove River to be connected with the French colony at the Gaboon. The stations are to be connected by telegraphic wires, the planting of which will be preliminary to the building of railways, so that these wires, says M. de Lesseps, will become for Africa, as they were across our Western Plains and are for Australia and for the Russians in Central Asia, real conductors of civilization.

PROFESSOR HENRY DRAPER writes in the November number of the "American Journal of Science" that, "during the night of September 30, 1880, I succeeded in photographing the bright part of the nebula in Orion in the vicinity of the trapezium. The photographs show the mottled appearance of this region distinctly. They were taken by the aid of a triple objective of eleven inches aperture, made by Alvan Clark & Sons, and corrected especially for the photographic rays. The equatorial stand and driving clock I constructed myself. The exposure was for fifty minutes. I intend at an early date to publish a detailed description of the negatives."

M. ABEL PIFRE has succeeded, by changing the form of the reflectors and the heaters, in considerably increasing the efficiency of the solar engines invented by M. Mouchot. While M. Mouchot has not been able to utilize more than fifty per cent. of the heat of the sun, M. Pifre with his improved apparatus makes eighty per cent. available for use. With a receiver of 9·25 square metres and a clear sky he boils fifty litres of water in less than forty minutes, and obtains an additional pressure of one atmosphere every seven or eight minutes.

IT is proposed to make use of the hydraulic constructions and machinery at Airolo and Goeschenen for the maintenance of electric lights in the St. Gothard Tunnel.

A ROCK-DRILL run by electricity has been devised by Messrs. Siemens and Halske of England. It consists of a rod of steel-headed soft iron which moves through three coils of insulated wire; the middle coil is traversed by a constant current which magnetizes the rod, and the other coils are traversed by alternating currents which attract and repel the rod with rapid movements.

"NATURE" chronicles the death of Dr. Hofrath von Wagner, Professor of Technological Chemistry in the University of Würzburg. He was born at Leipsic in 1823, first taught in Nüremberg, and was the author of a standard work on chemical technology, translated into English by Professor Crookes in 1872.

LOUIS FRANÇOIS DE POURTALES.